POWER

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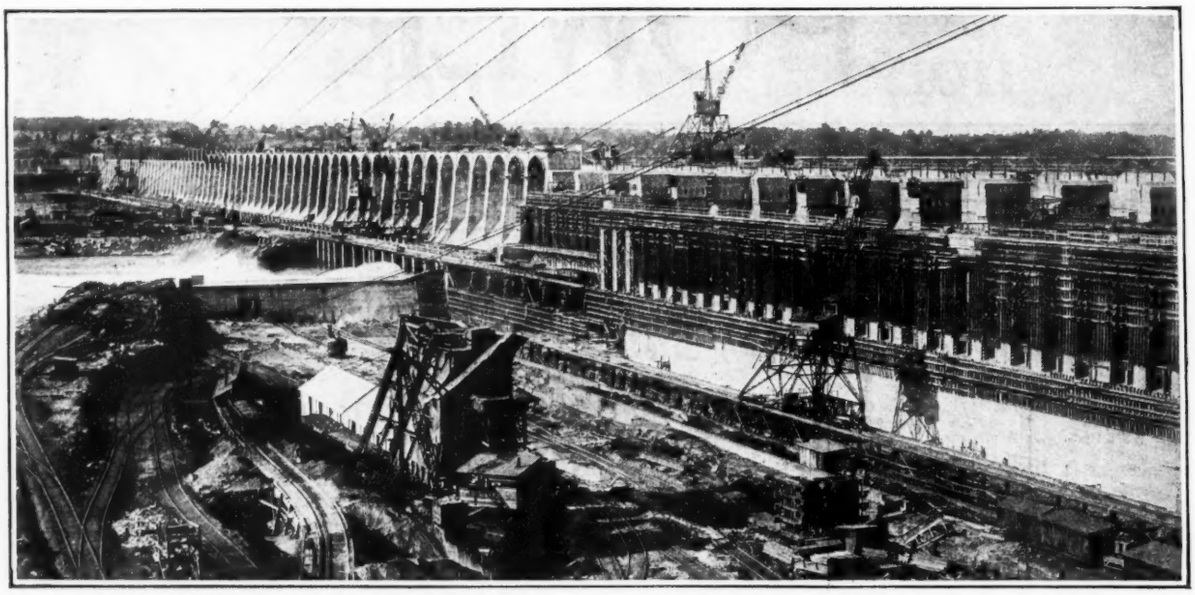
The Triple Responsibility of Industrial Leaders

AT A testimonial dinner recently given to Owen D. Young, Herbert Hoover pitched the obligations and responsibilities of the leaders of industry on the following high plane:

> Manufacture and distribution on a vast scale is the foundation of our high standards of living and the general comfort of our people. It can be accomplished in no other way than through the development of great units of production. With their development have come innumerable problems of public relationship and public responsibility. We are in fact today witnessing a rapid evolution and perhaps a silent revolution in the relationship of great business to our social system. We are struggling to preserve the fundamental stimulus of action, of initiative and competition, to hold open the avenues of opportunity. At the same time we are struggling to gain the benefits of co-operative action. In this period of evolution nothing is more needed than clear vision of their public responsibilities on the part of industrial leaders. For here is a triple trusteeship—a trusteeship to the owners who ultimately must be comprised from the savings of those who endeavor to provide security for their dependents and for their old age. These must have proper stimulative return as a reward for their enterprise and their self-denial. There is the trusteeship for a vast body of employees that they should have stability in employment and a sense of security for work conscientiously performed, that they should have a growing standard of living and comfort, and full opportunities for recreation and education. There is an equal trusteeship to the whole public who are served by the products of these enterprises. It is in the public interest that the product should be multiplied; should be given with every advantage of technical excellence and service and upon the best terms which can be attained with due regard to the two other strong obligations toward which our leaders must also look. This trusteeship goes even further. Constant gains to each group depend upon the elimination of waste and the constant development of science and invention, of increasingly more efficient organization. Beyond this again these organizations must be held high in the business and ethical relations by the character of their leaders. They must be conducted in a fine sense of non-interference with human rights.

If big business is conducted with impartial consideration of and deference to the rights and equities of these three classes, the revolution of which he speaks will be not only bloodless, but purged of bitterness and discontent.

F. R. Low



Dam No. 2 (Wilson Dam), power house and locks 4,500 ft. long

Muscle Shoals One of the World's Largest Water Powers

Power Possibilities of the Tennessee River—At Muscle Shoals 850,000 Hp. To Be Developed—Plant for 600,000 Hp. Nearing Completion with 260,000 Hp. Installed—Outline of the Government Undertaking at Muscle Shoals

PROBABLY, so far as the name may stand for something, Muscle Shoals has come to occupy a place in the minds of the American people equal to Niagara Falls, although comparatively few know exactly where Muscle Shoals is and a still smaller number have visited this much talked about war-time project. To the average individual Muscle Shoals is somewhere down South, is a tremendously large water power on which the Government has spent a lot of money, a good place to make fertilizer, and a project that Henry Ford and others have offered to take over from the government. It is the purpose of this article to review briefly the history of Muscle Shoals, show where this development is, point out what the water-power possibilities are, tell the present status of the undertaking and give a summary of the different offers that have been made to the government for taking over this property and the present situation with respect to its disposition by Congress.

Muscle Shoals is on the Tennessee River in the northwest corner of Alabama. This river is formed by the confluence of the Holston and French Broad rivers about five miles above Knoxville, Tenn., flows in a southwesterly direction into Alabama and after crossing the state in a semicircular course, turns almost due north and flows across the States of Tennessee and Kentucky into the Ohio River about 50 miles from the Mississippi, traversing a course of about 650 miles (see Fig. 1).

The flow of this river varies through wide ranges, from as low as 7,350 cu.ft.-sec. to 500,000 cu.ft.-sec. Naturally, a river having the size of the Tennessee, flowing through a country rich in coal, mineral and agricultural resources, would attract attention to its navigation possibilities. Probably for over one hundred years the people of the southeastern section of this country have been interested in having this river opened to navigation. Although the river carries a large volume of water, it has many shoals in its lower reaches which cut off the upper portions for navigation.

The most extensive of the shoals begins near Florence, Ala., about 260 miles from the river's mouth, and extends upstream for about 40 miles, in which distance there is a fall of 110 ft. These shoals, although having various names, have come to be generally known as Muscle Shoals. This section of the river offers the greatest obstruction to navigation, although there are other shoals farther up. At Muscle Shoals the river is wide and shallow with a blue limestone bottom, and the water seldom exceeds five feet deep during high water and is about one foot at low water. On this section the banks are comparatively high, which makes it suitable for power developments. Furthermore, the power developments also make this section of the river suitable for navigation at small additional expense to that required for the power project.

As early as 1832 the State of Alabama built a canal around these shoals, which fell into disuse soon after completion, but was partly reconstructed in 1890. This canal, however, did not prevent interest in developing the river for navigation and power purposes. As early as 1907 extensive studies were made by the federal

government looking toward improvement of the river at Muscle Shoals for navigation and for power development. Since that time different plans have been proposed for developing this section of the river by government or private interests. The last and most important of these was one that proposed a co-operative agreement between power-company interests and the United States government for a joint development for power and navigation purposes. This idea was abandoned when the National Defense Act was passed in 1916.

When Work Was Started

Nothing definite was done with this project until after this country entered the World War, when, early in 1918, construction work was started near Muscle Shoals by the United States government on a large atmospheric-nitrogen fixation plant for use in the manufacture of explosives during the war and fertilizer in peace time. To supply power to the nitrate plant, work was started on a large steam plant, and later in the year work was begun on the water-power project. Since that time construction on the water-power development has been carried on continuously with the exception of two periods, one during the last half of 1918 and the other from April, 1921, to July, 1922. This work at all times has been under the direction of the United States Army Engineer Corps. Since May,

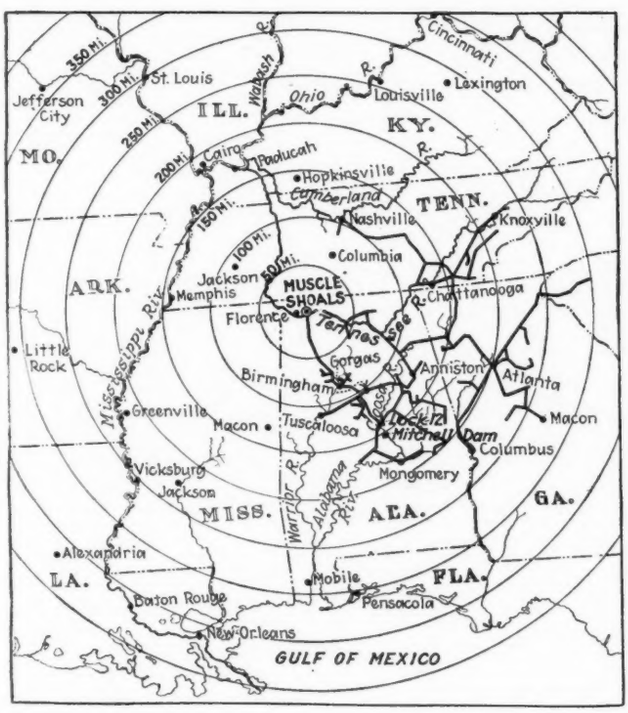


Fig. 1—Principal cities and transmission lines adjacent to Muscle Shoals

1923, it has been directly in charge of George R. Spalding, Lieutenant Colonel, Engineer Corps, U. S. A., who acts as district engineer at Florence, Ala., and reports directly to Chief of Engineers, Major General Harry Taylor. In May, 1920, Hugh L. Cooper & Co. were retained by the Engineer Corps as consulting engineers for the project. The work has been done by day labor employed by the Engineer Corps, and at times as high as 4,500 men have been at work.

The plan of development of the Tennessee River at Muscle Shoals by the government involves three dams and two power houses, with locks at each of the dams for navigation. The locations of these dams are indicated on Fig. 2 and they are known as Dams Nos. 1, 2 and 3. Dam No. 1 is for navigation purposes only and increases the surface of the water level about 8 ft. and will be used as a means of deepening the channel be-

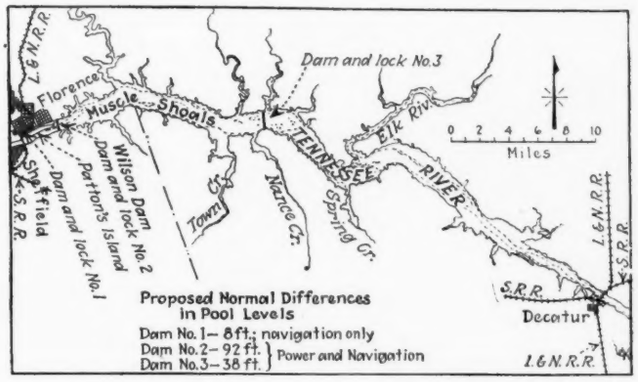


Fig. 2—Locations of Muscle Shoals projects

tween Patton's Island and the north shore of the river. Nothing has yet been done on this project.

In passing it might be mentioned that the proposed navigation improvement of the Tennessee River calls for a channel six feet deep at ordinary low water and five feet deep at extremely low water. For the 260 miles distance from the mouth of the river to Florence, Ala., the work has been practically finished. The completion of the Muscle Shoals project will add 85 miles more to the navigation route.

Three Dams and Two Power Houses in Project

Dam No. 2, or what has come to be known as Wilson Dam, is about three miles above Dam No. 1. This is the largest and most important of the three projects. It includes a power house and two locks, the latter to pass navigation from one water level to the other over the dam. The total cost of this undertaking will be about $51,000,000. With the present unregulated flow of the river it is estimated that 700,000,000 kw.-hr. of primary power and 1,490,000,000 kw.-hr. of secondary power can be generated at this site. Primary power is that which can be supplied continuously, and secondary power is that which can be supplied only part of the time, on account of insufficient water.

About twenty miles upstream from Dam No. 2 is the site of proposed Dam No. 3, which will be a combined power and navigation project. This development will operate under a head of 38 ft. and have an installed capacity of 250,000 hp. It is estimated that the cost will be $25,000,000, which includes the locks, dam and power house. Using the unregulated flow of the river, it is estimated that 285,000,000 kw.-hr. of primary power and 608,000,000 kw.-hr. of secondary power can be produced annually. When the upper river is regulated by the construction of storage reservoirs and water-power developments, it is believed that these values can be increased about 30 per cent, which would bring the total possible power at Dams Nos. 2 and 3 up to about 4,000,000,000 kw.-hr. annually. It is estimated that 2,000,000 hp. can be developed in the Tennessee River above the Muscle Shoals projects, of which only a small part has already been developed.

Dam No. 2 is one of the largest structures ever reared by the hand of man and is now nearing completion. In the entire project there will be required 1,400,000 cu.yd. of masonry. This is sufficient to build a wall one foot thick by three feet high and 2,400 miles long. The total length of the dam, including the power house and locks, is about 4,500 ft.; of this length, 2,668 ft. is a spillway and 232 ft. a sluiceway section. The power-house section is 1,250 ft. long and the locks about 200 ft. The dam is 95 ft. high from the river's bed and 101 ft. wide at the base exclusive of the apron. On the dam's crest will be 58 steel gates, each 38 ft. wide by 18 ft. long, designed for a discharge of 950,000 cu.ft.-sec. Above the gates is an operating bridge from which the gates will be operated by a control system that will permit one man to open or close all of them in two hours. A 28-ft. roadway will be supported over the dam on arches.

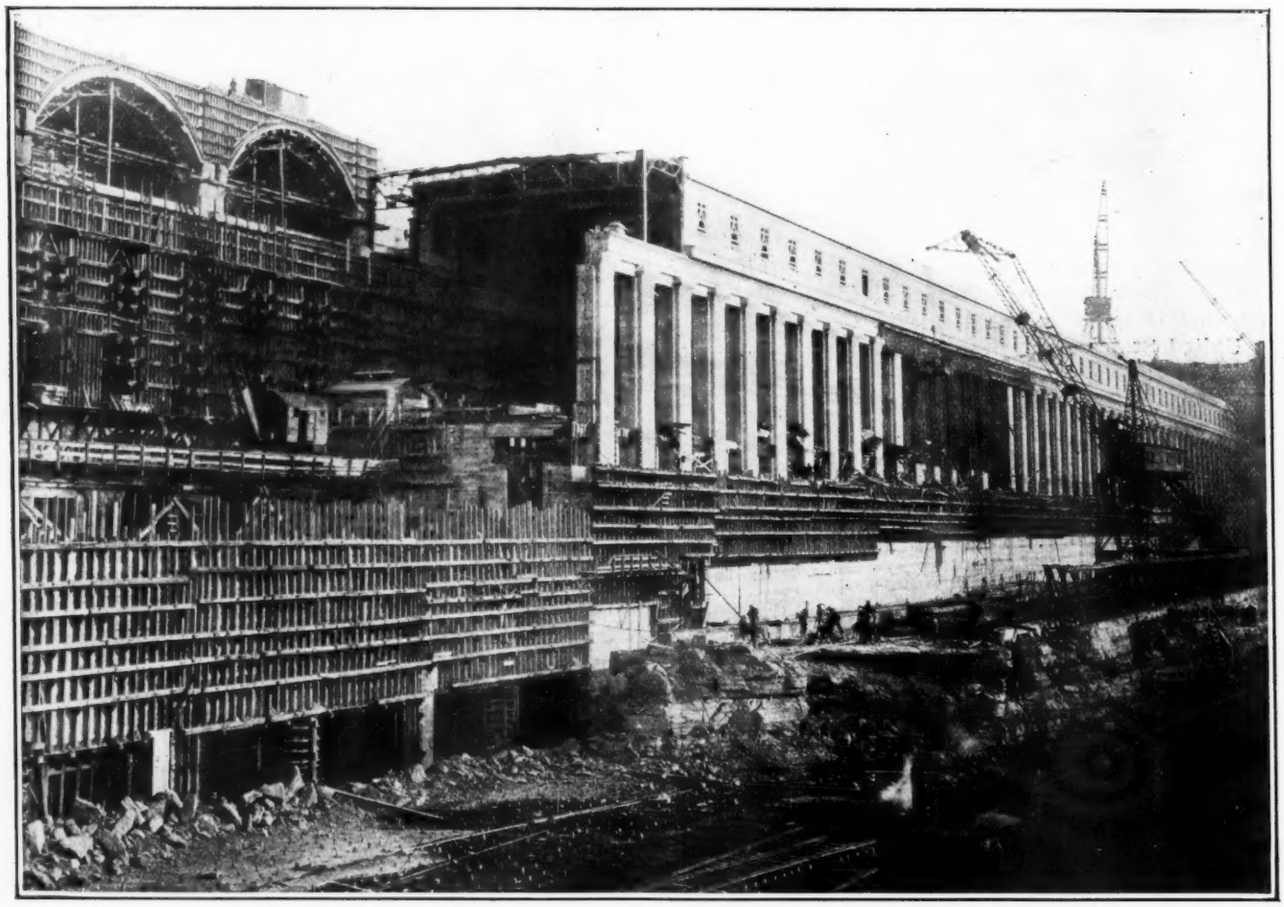


Fig. 3—Power house and sluiceway end of the dam under construction

Concrete construction is used throughout the dam, which is of the gravity type and is designed to resist a head of 95 ft. It will form a storage reservoir and forebay about 18 miles long with an average width of three-quarters of a mile. When the whole project is completed, the headwater level at Dam No. 2 will be tailwater level at Dam No. 3. On the opposite end of the dam from the power house are the two locks, each 60x300 ft. inside dimensions. They will each have a lift of 46 ft. 6 in. at normal water level.

The power-house structure is built into the dam and is now laid out to contain 18 units of which four will be rated at 30,000 hp. and fourteen at 35,000 hp., or a total of 610,000 hp. Four 30,000-hp. and four 35,000-hp. machines are now being installed and all eight are to be ready for operation by December, 1925. This gives an initial capacity of 260,000 hp. The power house and all other construction work will be completed in the initial undertaking with the exception of installing the machinery for the last ten units. The draft tubes and all waterways for these will be completed so that all future work can be done without any unwatering.

Since the unregulated flow of the Tennessee River varies through very wide ranges, from about 7,350 to 500,000 cu.ft.-sec., the power that can be generated in the power houses at Muscle Shoals will vary widely. It is estimated that the power at Dam No. 2 will be as follows:

Per Cent of Time			Horsepower
100			75,000
97			100,000
88.3	about 10	months	141,000
66.66	about 8	months	205,000
50	about 6	months	306,000
20	about 2½	months	600,000
7	about 1	month or less	1,000,000

This last figure is not possible since the capacity will not be installed to generate the power. However, regulation of the river will reduce the flood periods and increase the value of the continuous power. From these figures it is evident that before Muscle Shoals can be relied upon as a large source of continuous power, it must be connected to a large-capacity steam plant, or into a system that can economically absorb a large amount of peak power.

Undoubtedly, the power possibilities of Muscle Shoals have been overestimated. Although the tremendous volumes of water that flow down the river for short periods could, under the heads available at Muscle Shoals, develop about 6,500,000 hp., which is nearly equivalent to the total power of Niagara Falls, this power is available for such short periods as to make it uneconomical of development. Even for 20 per cent of the time 850,000 hp. is about all that can be expected at Dams Nos. 2 and 3, where the continuous power from the unregulated flow of the river will be about 100,000 hp. The continuous power from the unregulated flow of the river will probably be below this estimate, because the government regulations of the river require that when the flow is below 10,000 cu.ft.-sec., it must be passed continuously. This being the case, it would not be possible to store water even should the power load drop below a value requiring the flow of the river.

Atmospheric Nitrogen Fixation

Power and navigation are only part of the interests in Muscle Shoals. What is probably the most important, is the part it will occupy in our national defense program. In this, the fixation of atmospheric nitrogen is a major element and involves the manufacture of explosives in time of war and fertilizers in time of peace.

Since 1830 this country has imported from Chile sodium nitrate to the value of over $1,000,000,000. Of this price over $200,000,000 has been paid as an export tax to the Chilean government. This probably might not be such an undesirable condition if it were not for the fact that the nitrate deposits of Chile are thousands of miles away from this country and in case of war if we were cut off from this supply we might find ourselves in a very embarrassing position with respect to the manufacture of explosives. So it was that the National Defense Act passed by Congress in 1916, carried an appropriation of $20,000,000 to be spent at the direction of the President to determine the best method for atmospheric-nitrogen fixation. As an outcome of this, laboratory research was started and is still being carried on, under the direction of the Department of Agriculture.

A second development under this Act was the construction of what is known as Nitrate Plant No. 1, near Sheffield, Ala., about five miles from Muscle Shoals, and now part of this project. It was built as an experimental plant in 1917 to determine the possibilities of the Haber process of nitrogen fixation and has a capacity of only thirty tons of nitrogen per day in the form of ammonia. Although this plant was built at a cost of $13,000,000 and served its purpose as an experimental project, it is doubtful if it can be used except after expending a large sum for remodeling. This project also includes a 5,000-kw. steam plant, about 200 dwelling houses of various kinds, 8.6 miles of macadam roads, 4.5 miles of railway tracks, sewers, a water plant and other necessary auxiliaries for the operation of a small town that covers 1,900 acres.

Nitrate Plant No. 2 Practically Completed

Nitrate Plant No. 2 employs the cyanamide process, is located near Dam No. 2 and was built during the latter part of the war at a cost of about $55,000,000. This plant was designed for the fixation of atmospheric nitrogen in the form of ammonia, which was then to be converted into nitric acid and ammonium nitrate for the manufacture of explosives. During the war there was a shortage of ammonia in this country. It was also desirable to render us independent of Chile both on account of the danger of being cut off from this nitrate supply and also to relieve the shipping for other purposes. This plant was practically completed at the close of the war, and although it never has been put into active production, tests have shown that it is capable of producing the 40,000 tons of nitrogen per year that it was designed and laid out for. This is equivalent to the nitrogen content of 250,000 tons of sodium nitrate imported from Chile, or about 70 per cent of that imported in 1923 for American agricultural purposes, or 25 per cent imported for all purposes.

Nitrate Plant No. 2 is reported to be the largest in the world and includes a good-sized town in itself, covering about 2,300 acres. In addition to the six separate plants for various chemical purposes there is a 60,000-kw. steam plant, which was built to supply power until the hydro plant at Dam No. 2 could be put into operation and then to act as a stand-by station to the water power. This plant, which cost $12,000,000 and was practically completed at the signing of the Armistice, has been leased to the Alabama Power Company.

Included in Nitrate Plant No. 2 project are 186 permanent homes and a 100-room hotel equipped with all modern improvements. There are also 366 partly finished homes, 22 miles of improved streets with sewers, water and electric-light supply, a 60,000,000-gal. water reservoir with filter and pumping equipment, a 50-ton per day ice plant, and 37 miles of standard-gage railroad.

Waco quarry, at Russellville, Ala., 25 miles from Muscle Shoals, is also part of Nitrate Plant No. 2 and is to supply limestone for the nitrogen-fixation process. This quarry has cost the government $1,300,000.

The Muscle Shoals property, when Dam No. 2 and power plant are completed will have cost the government $131,300,000. To build Dams Nos. 1 and 3 and the power house at the latter, it is estimated will bring the cost up to about $164,000,000. The total property has an area of 7 square miles, or 4,500 acres.

Gorgas Steam Plant

The 50,000-kw. steam plant at Gorgas, Ala., although not part of the Muscle Shoals project, should be mentioned as it has come into prominence in considering the disposition of the Muscle Shoals property. This plant is at Gorgas, Ala., in the coal fields on the Warrior River, about 90 miles from Muscle Shoals, and was originally designed and built by the Alabama Power Co. to form part of its power system. One 20,000-kw. unit was finished and put into operation in September, 1917, and the foundations were in for a second 20,000-kw. unit which was on order. When the government began the construction of Nitrate Plant No. 2, at Muscle Shoals, it requested the Alabama Power Co. to supply power for construction purposes and to operate the nitrate plant until power would be available from Muscle Shoals. The company's system was already overloaded so that an agreement was entered into with the government for the company to cancel the order for the 20,000-kw. unit and in its place have built a 30,000-kw. machine. This machine was installed on the foundations of the 20,000-kw. machine, which were modified for the larger unit. A 90-mile transmission line was built on the company's right of way from Gorgas to Muscle Shoals, in the record time of five months. Power was delivered from the company's system to Muscle

Shoals from May, 1918, until the signing of the Armistice. The government interest in this property was sold to the power company, for $3,472,487.25, title passing to the company Sept. 24, 1923, the sale of the property being in accordance with a clause in the original agreement.

For the Muscle Shoals property the government has received several offers, of which those made by Henry Ford, Associated Power Companies, Elon H. Hooker, and Union Carbide Co., have been seriously considered by Congress. Although various attempts have been made to draw a comparison of the offers as to their relative merits, it is acknowledged that there is no basis upon which they can be compared, since the different proposals are not all for the same period of years and involve different amounts of the property. Furthermore, financial return is not the only consideration, since the maintenance of the property in a condition so that it will be readily available for any national-defense emergency is probably of greater importance. Closely allied with this is the fixation of atmospheric nitrogen for fertilizer.

Henry Ford has withdrawn his proposition, but a brief summary of the four offers mentioned may be of interest.

Résumé of Offers Made for Muscle Shoals Project

The Ford offer, which was the first made to the government, proposed to form a corporation with a cash capital of at least $10,000,000. This corporation was to lease Dams Nos. 2 and 3 with their power equipment when installed, for 100 years. The rental for the lease was to be based on 4 per cent per annum of the cost to the government, less $17,000,000 spent on Dam No. 2 before May 31, 1922. The lessee was to create a fund to amortize the cost of the property in 100 years. This corporation would purchase all property constituting Nitrate Plants No. 1 and 2 and Waco Quarry and the Gorgas steam plant or its equivalent, for $5,000,000.

In operating these plants it was agreed to produce fertilizer each year containing at least 40,000 tons of fixed nitrogen at a cost that would give the corporation a profit of not over 8 per cent per annum. The corporation also agreed to carry on research work to improve the processes for manufacturing fertilizer, this agreement to be carried out under the direction of an advisory board of three members representing the farmers, the government and the Ford corporation.

According to the Associated Power Companies' offer a $15,000,000 corporation was to be formed which was to lease Dams Nos. 2 and 3 and their power-generating equipment for 50 years, at a rental of 4 per cent per annum on the construction costs. If Dam No. 3 and its power plant were built by the power company, the provisions of the Federal Water Power Act were to apply. If the manufacture of fertilizer proved successful, its production was to be increased by enlarging Nitrate Plant No. 1 until it reached the equivalent of 50,000 tons of fixed nitrogen a year, as rapidly as a demand for this amount was created, and sell it at a price that would pay not over 8 per cent profit. The corporation was to set aside in ten years a fund of $1,000,000 for research in nitrogen fixation processes. Nitrate Plant No. 2 was to be maintained in readiness to manufacture explosives at government expense. A board appointed by the government and the corporation was to supervise the production and the distribution of fertilizer, and the power plants were to be operated under the Federal Water Power Act.

The Elon H. Hooker offer proposed a corporation having a cash capital stock of at least $1,000,000, which was to lease the plants, both nitrate and power, and operate them for and at government expense. The earnings of this company were to be limited to 8 per cent of the sales price of all fertilizer manufactured. This agreement also called for the setting aside for research work $50,000 a year from the net profits, when a reasonable sale of power was made from the plant at Dam No. 2. The amount for research work was to be increased to $200,000 a year when the plant at Dam No. 3 came into commercial operation. From the annual net earning made from the sale of power and fertilizer the corporation was to pay interest on its preferred stock, create a fund to amortize the cost of the power project, after which the remaining profits were to be divided between the government and the common stockholders, giving the government two-thirds for the first ten years and three-quarters thereafter. This agreement was to be carried out under an advisory committee representing the government and the corporation.

The Union Carbide Co. offer proposed to form a corporation having an initial paid in capital stock of not less than $1,000,000, which would lease Dam No. 2, Nitrate Plants Nos. 1 and 2, and Waco Quarry for the terms of 50 years. In case the government completed Dam No. 3 and its power house before the termination of the lease, the corporation would have the preferential right to lease this property for fifty years. Rental for Dam No. 2 property was to be $750,000 a year for the first six years, $1,500,000 a year for the next four years and $2,150,000 a year for the remaining 40 years of the lease, plus $25,000 a year for each additional generating unit in excess of 14. Rental for Nitrate Plants Nos. 1 and 2, including the 60,000-kw. steam, was to be $375,000 per year and 5 cents a ton was to be paid for all limestone removed from Waco Quarry. Under the terms of the lease the government would have the right to recapture the property on five days' notice to the lessee.

Fertilizer or fertilizer compounds were to be manufactured in Nitrate Plant No. 2 annually in amounts containing not less than 20,000 tons of fixed nitrogen at a cost plus 5 per cent. The company would also endeavor to use Nitrate Plant No. 1. The company agreed to carry on research work at a cost equal to one-half of the profits on fertilizer compounds during the first 10 years of the lease, and during the remaining years of the lease one-half of these profits were to be set aside as a fund to amortize the costs of Nitrate Plants Nos. 1 and 2.

Possibility of Making Fertilizer

Although all these offers carried fertilizer clauses, the commercial production of fertilizer from atmospheric nitrogen is still an open question. When testifying before the Senate Committee of Agriculture last spring, Major Gen. C. C. Williams, Chief of Ordnance, U. S. A., said: "The feasibility of producing nitrogenous fertilizers by fixation of atmospheric nitrogen for use under American conditions is still open to doubt. While the United States is a heavy importer of Chilean nitrate, it has also become an exporter of ammonium sulphate, this latter material being representative of a class of materials most generally produced by nitrogen fixation. The nitrogen-fixation plants which have

been established in this country are producing ammonia for the high-priced refrigeration or chemical trade, and have not, as yet, entered the low-priced fertilizer market. If the products are to be of any material benefit to the farmer, they must be sold at prices lower than those as yet attained. At prices existing four years ago it seemed quite probable that U. S. Nitrate Plant No. 2 could be operated for fertilizer production on a self-sustaining basis. At that time ammonium sulphate was selling in excess of $100 a ton. Since that time ammonium sulphate has sold as low as $40 a ton and is now quoted at $53, which is somewhat less than one-half the price of four years ago. Four years ago acid phosphate was quoted at $19 per ton and is now $7.50 per ton, which is materially less than half of the price during 1920. I have quoted these figures to illustrate the uncertainty of the fertilizer market which has, no doubt, been carefully considered by everyone offering to undertake production at Muscle Shoals. There is a chance of a heavy loss being incurred in guaranteeing to produce a fixed quantity of fertilizer."

Furthermore, the trend in present developments in processes for the fixation of atmospheric nitrogen is away from large-power requirements and toward more strictly chemical processes. The power required per ton of atmospheric nitrogen fixed by the arc process, which was the first, is 67,000 kw.-hr., by the cyanamide process 14,500 kw.-hr., and by synthetic-ammonia process about 4,000 kw.-hr. Therefore what the future holds in this respect is open to conjecture as is also what the government will finally do with its Muscle Shoals property. At present it is going ahead and completing Dam No. 2 with its power plant. At this time it is doubtful if any of the foregoing offers hold the final disposition of this property. The latest proposition for disposing of Muscle Shoals is the Underwood Bill, which has recently been brought before Congress.

This proposed act empowers the Secretary of War to lease all the property at Muscle Shoals including power and nitrate plants for a term of years, not exceeding 50. The lessee shall pay a rental for the use of this property amounting to not less than 4 per cent on the total investment at Dam No. 2. This lease also provides for the manner in which the surplus power shall be sold and for the maintenance of the equipment and protection to navigation. The lease also requires that 10,000 tons of fixed nitrogen be produced the first year and increase 10,000 tons a year when during the fourth year and each year thereafter 40,000 tons are to be produced. Fertilizer containing this nitrogen is to be sold to the farmers under direction of the government at a price that will allow not over 8 per cent profit on a fair cost of production. The government is to retain the right to recapture the property on five days' notice.

In event that the Secretary of War is unable to make a lease under the terms granted in the proposed bill, before the first day of July, 1925, then the United States shall maintain and operate the property in compliance with the terms set forth in the act. The President shall be empowered to designate five persons to act as an organization committee for the purpose of forming a corporation under authority and for the purpose enumerated in the act. This corporation to be known as the Muscle Shoals Corporation.

Operation of Electrical Temperature Indicators and Recorders

By E. H. STIVENDER*

Briefly describes the operation of various methods that have been devised and used commercially for electrically measuring temperatures.

In recent years the practice of centralizing meters and gages in power stations has become common practice, and to keep pace with the requirements the electric pyrometer has been developed to a high degree. The instruments described in this article operate on the thermocouple and resistance systems, which are the types in commercial use today almost universally.

Fig. 1 is a diagram of a thermocouple instrument for recording temperatures. The scale is so graduated that the position of the slider S is proportional to the voltage at the terminals of the thermocouple and therefore the temperature of the machine in which the couple is located. Its operation is as follows:

The battery E, in the figure tends to send a current through resistance C and part of P to S, thence through the thermocouple and the galvanometer G, through D and back to battery negative. Likewise the thermocouple tends to send current through S, part of P, resistances B and D, galvanometer G and back to the negative of the couple. It is thus seen that the two voltages tend to send current in opposing directions through the galvanometer G. At a predetermined position of the slider S, which indicates temperatures on a scale, the two voltages will be equal with the galvanometer pointer on zero. The instrument will then read a certain temperature for which it is calibrated.

When the temperature drops, thereby causing the voltage of the couple to decrease, the battery being of constant voltage will send current through G toward the left and cause the galvanometer's pointer to be deflected. To bring the pointer back to zero, the slider S is moved to the left, which increases the resistance of the battery circuit and decreases the resistance of the thermocouple circuit. The instrument will then indicate a new temperature. When the temperature rises, a reverse operation is undergone.

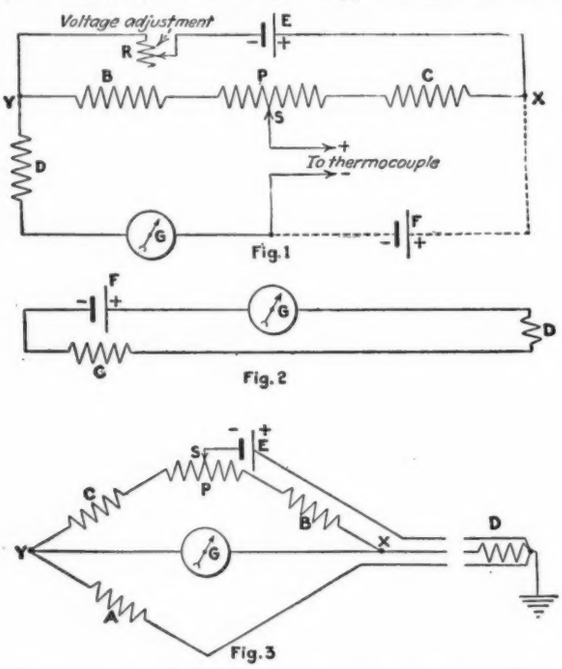
At intervals the voltage of E should be checked by opening the thermocouple circuit and comparing the voltages of the battery and a standard cell by the arrangement shown in the dotted line. This is more reliable and convenient than the voltmeter method and small adjustments can be made with the galvanometer and rheostat R.

*Sanderson & Porter, Engineers and Contractors, New York City.

The joints to thermocouple instruments should all be soldered to eliminate dry-joint resistance, negligible in most other instruments. The resistor *D*, Fig. 1, is the cold-junction compensator made of an alloy which decreases in resistance as it increases in temperature, thereby compensating for the effect of changes in atmospheric temperature on the copper leads of the thermocouple. Owing to the difficulty of making this absolutely reliable, as in many cases the leads are partly outside and partly inside the instrument room, some authorities recommend burying the cables several feet in the ground where the temperature is practically constant and omitting the resistor *D*.

Thermocouples are made of different combinations of metals welded or riveted together. Types used for generator and transformer measurements are usually the copper-constantan and iron-constantan combinations, in which constantan is negative.

For indicating temperature the potentiometer can be omitted and the galvanometer calibrated in degrees. Where a number of readings in different parts of a machine, such as incoming air, outgoing air, windings, etc., are desired, a dial or drum-type switch is used for



Figs. 1 to 3—Diagrams of temperature-measuring systems

Fig. 1 Potentiometer and thermocouple system. Fig. 2—Simple series type with temperature coil. Fig. 3—Combination slide wire and bridge system.

switching in differently located couples. The slider, dial switch, printing and timing mechanisms used with the scheme shown in Fig. 1, can be made automatic and driven by a motor.

Resistance System, Series Type

In early experiments with the resistance system the arrangement shown in Fig. 2 was constructed, with the galvanometer *G* graduated in degrees. The deflection of the pointer was directly proportional to the temperature changes of resistance coil *D*. As the changes in generator and transformer temperatures are relatively small, several degrees difference could hardly be read on the instrument, also the voltage of the operating battery *B* had to be constant for accurate results. Commercial temperature indicators of today are arranged so that the ratio of the pointer deflection to the temperature change is greater than one, and voltage changes will not affect the readings to such a great extent.

Bridge System Using Direct Current

The system of temperature measurement shown in Fig. 3 is used extensively for recorders and is a Wheatstone or slide-wire bridge in which the position of the

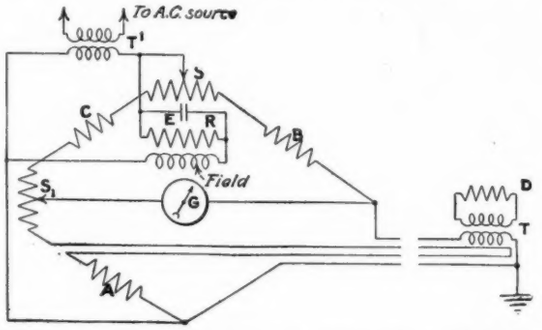


Fig. 4—Alternating-current slide-wire and bridge system with temperature coil

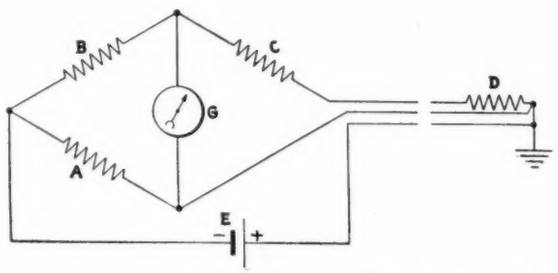


Fig. 5—Diagram of direct-reading system with direct current

slider *S* indicates the resistance and therefore the temperature of exploring coil *D*. If the resistance of circuit *ESBDE* bears such a relation to circuit *ESCAE* that the potential of *X* and *Y* are the same, no current will flow through galvanometer *G*. But should the temperature of the exploring coil *D* rise, the resistance of circuit *ESBDE* will be changed, which will result in an unbalanced potential across the galvanometer. This will cause a current to flow in the galvanometer and deflect the needle. To bring the galvanometer back to zero, the slider *S* is moved in the desired direction. If the temperature drops, the slider should be moved in the reverse direction until the galvanometer returns to zero.

It can thus be seen that the distance *S* moves, bears a relation to the change in temperature of *D*, this distance depending upon the resistance per unit of length in *P*. A change in operating voltage between reasonable limits does not affect the readings of this type of instrument, as the value of the unknown resistance is obtained when there is no voltage across *G*. The slider *S* is automatically moved in recording machines by an arrangement similar to that mentioned for thermocouple instruments.

Errors due to the resistance of the exploring-coil leads are corrected by making the junction of *AD* of equal resistance to *BD* by means of an extra wire to coil *D*. This has an advantage over using a compen-

sating resistor, as the resistance of the leads does not have to be known, and eliminates the use of special resistors for each temperature coil located in a machine.

Bridge System Using Alternating Current

In high-voltage transformer units it is undesirable to bring the leads from coils embedded in the windings to the switchboard because of the danger to the operator. In recent years the alternating-current system of temperature-indicator operation has come into use for such conditions, in which case the changes in temperature of the exploring coil affect the reactance in the primary of a small transformer located inside the tank of the large unit, where the instrument lead is grounded. Fig. 4 illustrates a system used in recording temperature indicators.

The operating current in Fig. 4 is furnished from a small transformer, the need for it being due to the ground at the insulating transformer *T*. The galvanometer in this case differs from those on direct-current instruments in its requiring a field supplied from alternating current. In very accurate pyrometers a condenser *E* is used to compensate for the inductive reactance of the system, which would otherwise affect the pointer deflection in a small degree.

Another method of line-drop compensation is illustrated in Fig. 4, where one arm of the bridge (that which does not contain the insulating transformer *T*) is brought out to the insulating transformer and back again without connecting to it, making the connections between resistors of the same length in each arm. This is known as the four-lead method as distinguished from the three-lead method of Fig. 3, and is not used often

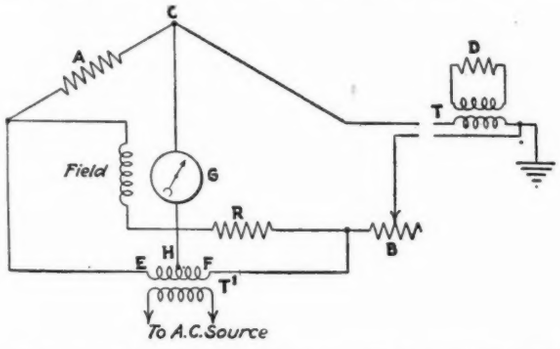


Fig. 6—Diagram of direct-reading system with alternating-current system

in industrial installations because of its requiring so much more wire than the latter scheme.

It will be noticed that there are two sliders *S* and S_1 used in Fig. 4. The one in the galvanometer circuit S_1 is used to lessen the time required for balancing, if only one were used. The two sliders, *S* and S_1, are fastened together mechanically and are moved at the same time. This arrangement provides a more rapid measuring system while at the same time it allows small adjustments.

Direct-Reading Bridge System Using Direct Current

Fig. 5 shows a diagram of a bridge system in which the temperature is read directly from the galvanometer, which has a dial graduated in degrees. This has the same characteristics as the slide-wire system except that the changes in voltage will affect the readings slightly. This error is determined by a factor that is directly proportional to the deviation from correct voltage and the amount the pointer deflects from the balance position. The voltage variation between practical limits has little effect on the correctness of the readings, but is important if very accurate readings are desired.

Direct-Reading Bridge Using Alternating Current

In Fig. 6 is shown a development of the bridge principle which is used for obtaining transformer temperatures. The galvanometer is constructed as in the other alternating-current types, but the bridge arms show a

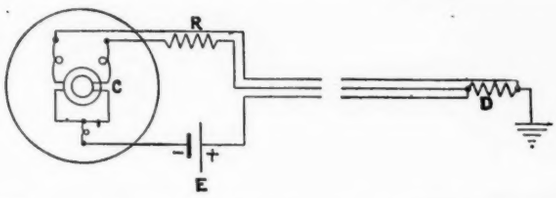


Fig. 7—Diagram of direct-reading differential-coil system

departure from the usual types, in that a tap is taken from the secondary of the operating transformer *T'*, thus eliminating two resistors.

In operation, the voltages between *E* and *H* and *H* and *F* are in the same direction at the same time, these two sections being part of the same transformer secondary. When the resistance of the circuit *FBTC* is the same as *CAEH*, points *H* and *C* will be at the same potential and no current will flow through the galvanometer. When the temperature of resistance *D* changes, it also changes the reactance of transformer *T*, which will cause a difference of potential to exist across points *C* and *H*, and a current will flow through the galvanometer *G*, causing a deflection of the needle.

Direct-Current Differential Coil System

In Fig. 7 is shown an arrangement that does not employ any of the principles previously discussed. Its operation depends upon the differential action of two coils *C*, which are wound in opposite directions on a movable core. One coil circuit contains a fixed resistance *R*, while the other contains the exploring coil *D*. When the resistance of *D* is equal to *R*, if two coils have the same number of turns and the same resistance, there will be no magnetism in the movable core. A spring holds the core in position, while the pointer fastened to it indicates a certain temperature. Should the temperature of *D* change, the balance between the coils will be destroyed and the pointer will indicate a new temperature, depending upon the value of the exploring coil resistance relative to *R*.

All exploring coils used near high voltages when an insulating transformer is not used should be grounded at the machine either direct or through a resistance in order to eliminate the dangers of electrostatic induction.

With instruments operated on alternating current errors due to electromagnetic induction are sometimes present. To check for these errors the insulating transformer leads should be reversed and notice taken of any different reading shown by the instrument. If that is the case, the correct reading would then be the average of these two. Induction in the temperature coil itself can be eliminated by winding it half in one direction and half in the opposite.

Anton Flettner and his experimental ship, the "Buckau"

Flettner's Sailless Ship Explained

Employs Principle of Curving Baseball—Spinning Cylinders Distort Wind Currents—Resultant Driving Force Ten Times That of Same Sail Area—Maneuvering Simpler Than with Sails—Inventor Predicts Use as Auxiliary to Engine Drive

SINCE the latter part of November the newspapers have made frequent reference to a sailless ship invented by Anton Flettner, a German engineer well known for his invention of the Flettner rudder, which is "steered" by a small auxiliary rudder at its free end.

While absurd claims were made for the Flettner ship in some of the early newspaper reports, authentic information, recently received by *Power* from Professor Stumpf and other German scientists, indicates that Flettner has attacked the problem in a scientific manner and that the practical possibilities of his method of ship propulsion are worthy of careful consideration, even though the commercial savings attainable may be less than enthusiasts have predicted.

While this is the first attempt to apply it to ship propulsion, the idea involved has long been known to scientists under the name of the "Magnus principle." This is based on the observed fact that when a current of air passes over a rotating body the resultant force on the body does not act in the same direction as the wind. By direction of the wind is meant its *relative* direction as seen by an imaginary observer stationed on the body. Only relative winds being pertinent, it makes no difference whether an actual wind moves by the body or an apparent wind is produced by the motion of the body through still air.

Curving Baseball Illustrates Principle

A baseball (Fig. 1) thrown with a counterclockwise spin acquires an "out" curve, while a golf ball driven with an "under" spin (Fig. 3) tends to rise or maintain horizontal flight for a time in apparent defiance of gravity. Finally, to take a less familiar illustration (Fig. 2), an artillery projectile with a right-hand spin "drifts" to the left during its downward path when it is inclined as shown to its trajectory. Each of these deviations from the expected path must evidently be due to a push at right angles (approximately) to the apparent wind produced by the motion of the object through the air.

It should be noted that *in each case the object tends to drift toward the side that is moving with the relative wind.* In the case of the baseball and tennis ball this is the side moving back toward the starting point.

In 1853 Heinrich Gustav Magnus, a German experimental physicist, investigated this effect with particular reference to the flight of projectiles, and propounded the so-called Magnus principle, which is accepted today as substantially correct. This is illustrated by the three diagrams of Fig. 4, which are more or less idealized but sufficient for the present purpose.

Magnus Principle Explained

As shown at *A*, wind blowing past a stationary cylinder slips by in stream lines symmetrically distributed on the two sides. While in practice there is some resultant force in the direction of the wind, the practically stream-line flow makes this force small (particularly for large cylinders) in comparison with that exerted by the wind on a flat surface of the same projected area. When this cylinder rotates in a calm, the air is dragged around in layers (*B*), the layer nearest to the surface moving fastest and the successive outer layers more and more slowly.

The combination of wind and rotation[1] is shown at *C*. The stream lines are no longer symmetrical, but more of the air flows by on the side moving with the wind, where the least resistance is encountered. It is a well-known law of hydraulics, as well as of aërodynamics,

[1] It should be noted that the wind has no appreciable tendency to rotate the cylinder. This must always be accomplished by outside power.

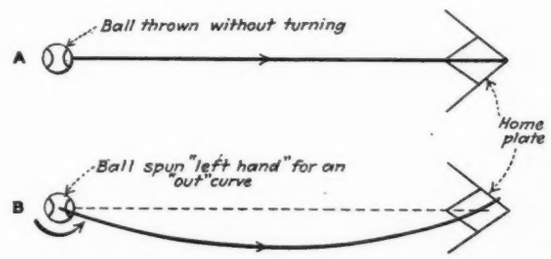


FIG. 1 Plan of Baseball thrown Straight (A) Curved (B)

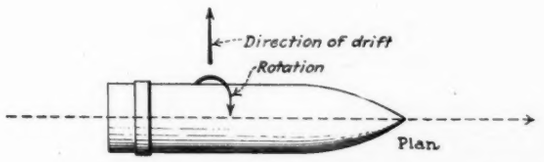


FIG. 2 The Shell on its Downward Flight is Tipped as Shown. Spinning Right Hand, the Left Side of the Shell offers less Resistance. The Result is a Drift to the Left.

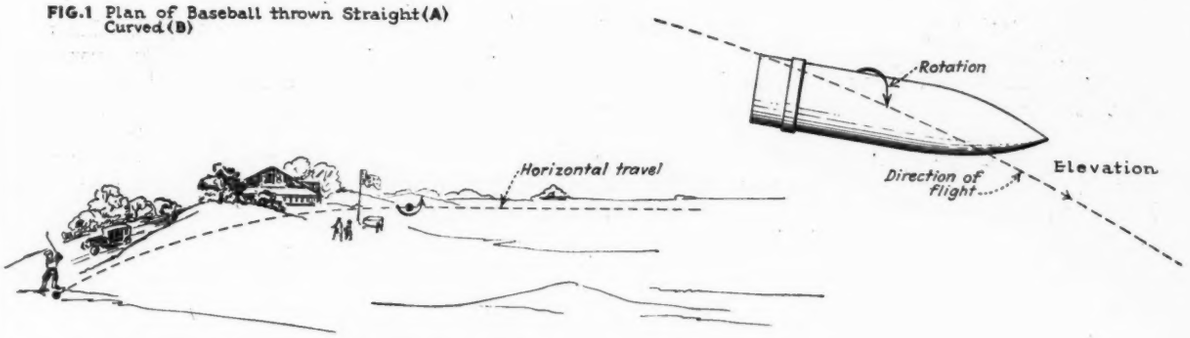


FIG. 3 A Golf Ball Struck Sufficiently Low with Club of Proper Shape will acquire enough Underspin to keep it in Horizontal Motion during Part of its Flight in Apparent Defiance of Gravity

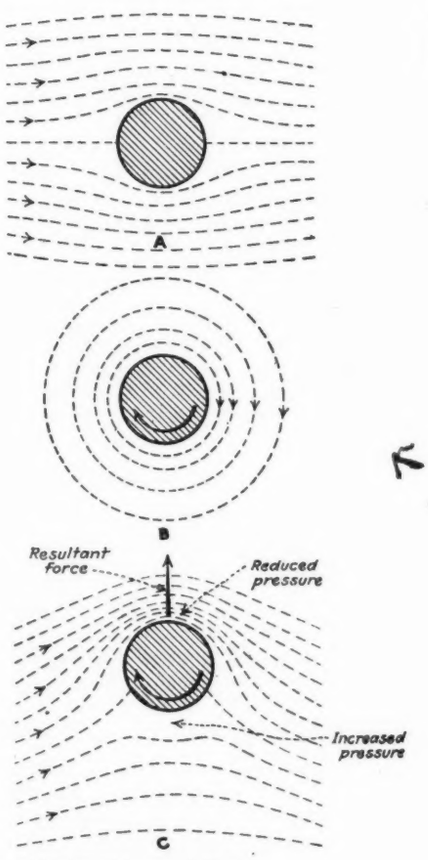


FIG. 4 The Magnus Effect.
A-Cylinder at Rest in a Wind
B-Cylinder Rotating in a Calm
C-Cylinder Rotating in a Wind

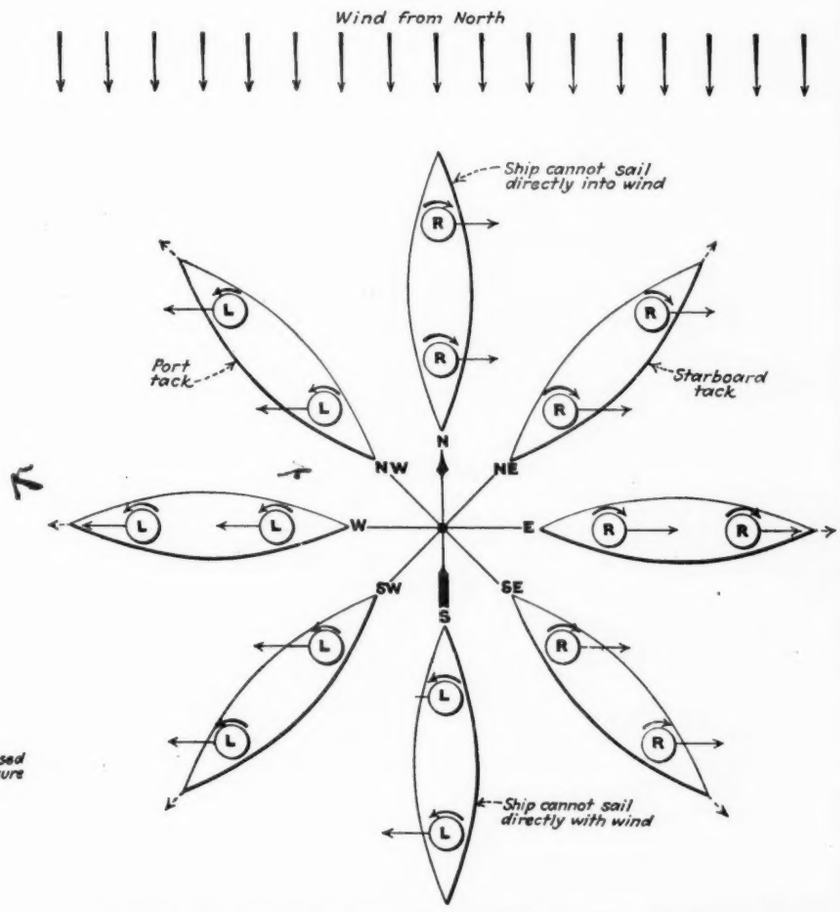


FIG. 5 How Ship Sails in Various Directions. Dotted Arrow at Bow Shows Motion. Solid Arrows on Cylinders Show Force. Note that Ship cannot Sail Directly Against or With the Wind

that pressure drops when velocity rises and vice versa. Hence there is a drop in air pressure on the side moving with the wind and an increase in pressure on the other side, with a resultant force about as shown. This is the Magnus effect.

The size of the resultant force depends on the velocity of the wind and also on the surface velocity of the rotating cylinder. Experiment has shown that it may easily rise to 16 times the force of the wind on the non-rotating cylinder. While, in practice, the resultant force is not exactly perpendicular to the wind (the angle varying with the two velocities) this variation need not be considered here. Designers of such ships may study this matter in detail.

From a study of the theory, followed by experiments with models of sails and rotating cylinders in the wind

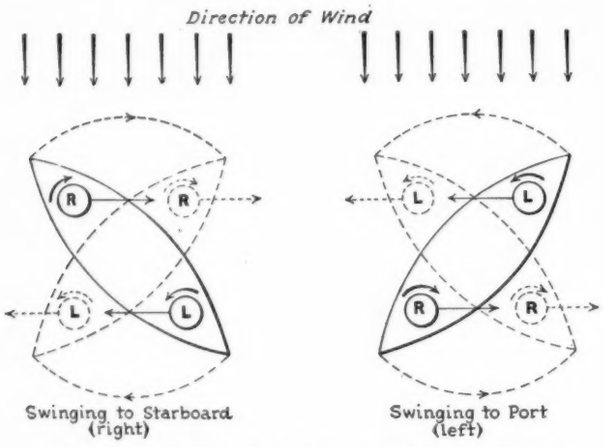


Fig. 6—"Coming about" is easily accomplished by rotating the two cylinders in opposite directions

tunnel of Göttingen Aërodynamic Laboratory, Flettner decided that he could at least equal the driving force of a sailing ship with rotating towers having one-eighth the projected area. He also found reason to expect greater safety, convenience and maneuvering ability.

Experiments with a full-sized ship seemed to bear out these expectations. With the backing of the Friedr. Krupp Co. (Kiel), the 600-ton auxiliary motor ship "Buckau" was chartered, equipped with rotating cylinders and given extensive tests.

Astonishing Results Claimed for 600-Ton "Buckau"

The two cylinders, constructed of a double layer of 0.04-in. thick sheet steel, are 9.2 ft. in diameter, 51 ft. high (later increased to 61 ft.) and provided with disks at the top to avoid "spilling the vacuum." They are mounted on pivots about 5 ft. in diameter, reaching 43 ft. above the main deck and are rotated by individual 11-kw. reversible direct-current 750-r.p.m. motors located inside the pivot supports above the main deck. The cylinders and drive have a total weight of seven tons, whereas the equivalent rigging would weigh 35 tons and extend 92 ft. above the deck. It is claimed that when the cylinders are at rest their resistance to the wind is much less than that of the bare spars, masts and rigging of an equivalent sailing ship.

Among the practical results claimed from the tests of this ship were the following: A speed of 9 knots in a gusty and shifting breeze; driving force equivalent to 10 to 15 times the same sail area; considerable reduction in size of crew; greatly improved stability and safety in squalls and stormy weather; increased maneuvering ability; ability to sail as close as 23 deg. into the wind; the development of powers up to 1,000 hp. from the wind when expending 20 hp. to rotate the cylinders.

The greater safety is said to be due to the fact that for the customary rotational speed the force on the cylinder attains a practically constant value when the wind velocity reaches 25 miles per hour. Further increase in wind velocity does not increase the force. As a result, if the reports are correct, the captain can forget about storms and squalls except so far as the waves themselves may reach dangerous proportions. The lower portions of the cylinders are reinforced to avoid damage by heavy seas.

The maneuvering ability is best understood by a study of Figs. 5 and 6. Fig. 5 shows that the ship may sail in practically any direction except straight against or with the wind.

A study of the diagrams indicates that the ship should sail best with the wind abeam; that is, with the wind at right angles to the length of the ship. While the driving forces are not exactly perpendicular to the wind as shown, it is apparently impracticable to sail directly with the wind, so that it becomes necessary to "tack" with the wind as well as against it.

"Comes About" Without Use of Rudder

Fig. 6 shows how, without headway or the use of rudder, the Flettner ship can be brought about from port tack to starboard or vice versa. By rotating the cylinders in opposite directions as shown, the two resultant forces constitute a couple or turning moment which persists at full strength even when the ship is headed directly into the wind.

Flettner does not claim that his cylinders will supplant steam or Diesel engines. It is his belief, however, that they will become an important auxiliary source of power in engine-driven freighters. On routes where steady cross-winds exist, large fuel savings are predicted.

News dispatches have spoken vaguely of stationary wind-power plants which will be built with the Flettner cylinders, but the few details so far mentioned do not make clear the method of their operation.

Maintenance Costs of Diesel Plants

The Diesel Engine Users Association (England) has issued a report carrying a tabulated list of the actual working costs of thirty-four Diesel and semi-Diesel installations in Great Britain. The average total engine cost of the thirty-four plants with a total output of over 26,000,000 kw.hr. and with an average annual plant load factor of 13.3 per cent, was 0.889 pence (1.8c.) per unit generated.

It is pointed out that the average figures were obtained from the working of undertakings in many of which the conditions of working were by no means favorable to obtaining the best results and that they do not represent the results obtainable from heavy-oil engine installations operating under reasonably favorable conditions.

In the case of the thirty-four plants dealt with in the report comprising 112 engines of over 22,000 kw. total capacity, the maintenance cost for the year worked out at £0.96 (approximately $4.50) per installed kilowatt.

Why Turbine-Driven Pumps Were Selected for Fairmount Station*

By L. A. QUAYLE, M.E.
Chief Engineer, Cleveland Water Department

THIS abstract covers a detailed preliminary comparison of prime movers made in connection with the design of the new Fairmount pumping station in Cleveland. The author reaches the important conclusion that, while turbine-driven pumps can hardly reach the duty of triple-expansion pumping engines when operating under the same conditions of steam pressure and temperature, it is practicable to raise the pressures and temperatures to a much higher point in the turbine plant, with the final result that a higher duty is obtained at a considerably lower first cost.

THE general description of Cleveland's new Fairmount pumping and heating plant was given in the Nov. 25 issue. Before proceeding to outline the analysis that determined the type of pump drive employed, a few facts about the station may be reviewed.

There are eight pumping units, all turbine driven, as follows: Three units, two of 75 m.g.p.d. and one of 50 m.g.p.d. pump water from Fairmount reservoir to the filter plant. The net head on these pumps is 80 ft. Two units of 20 m.g.p.d. pump filtered water from Baldwin reservoir (head 78 ft.) into first-high-service reservoir against average pressure of 213 ft.

The three second-high-service pumps of 20 m.g.p.d. are supplied with filtered water from Baldwin reservoir and discharge against a head of 478 ft., giving a net head of 400 ft. on pumps.

The first five units mentioned are of the single-stage, double-suction type, while the three second-high-service pumps have two impellers per casing.

All eight units are turbine driven through reduction gears. Three turbines are designed to bleed steam at 125 lb. gage, two to bleed at 3 to 10 lb. and two either to bleed at 3 to 10 lb. in the winter or to take auxiliary steam in the low-pressure stages at from 0 to 3 lb. in the summer. The turbine types are so arranged that one of each type required will be in service under the minimum pumpage conditions.

Steam at 300 lb. pressure is generated in four 10,000-sq.ft. Stirling-type boilers. Auxiliaries are driven by centrifugal pumps reversed to run as hydraulic turbines. More complete information and additional details were given in the first article, to which reference has already been made.

We may now proceed to a study of the factors determining the selection of prime movers for the pumping units.

Analysis of Steam Prime Mover Efficiency

In spite of performance records held by the crank- and flywheel-machine, the centrifugal pump has now found extensive use in the water-works field following the perfecting of a suitable reduction gear for connecting it to a steam turbine.

There are indications just now that water-works engineers are directing considerable attention to the use of higher steam pressures and temperatures along the lines laid down by the designers of large central-station electric generating plants. It would seem, however, that they should extend their studies of means for improving the economy of a pumping station to include, not only the gain that lies in the use of higher steam pressures and temperatures, but that gain which can be realized in the water-works steam turbine. With this in mind a study has been made of available turbine proposals, together with test records of other water-works machinery and of certain turbines used for electric generating service approaching the water-works turbine in size.

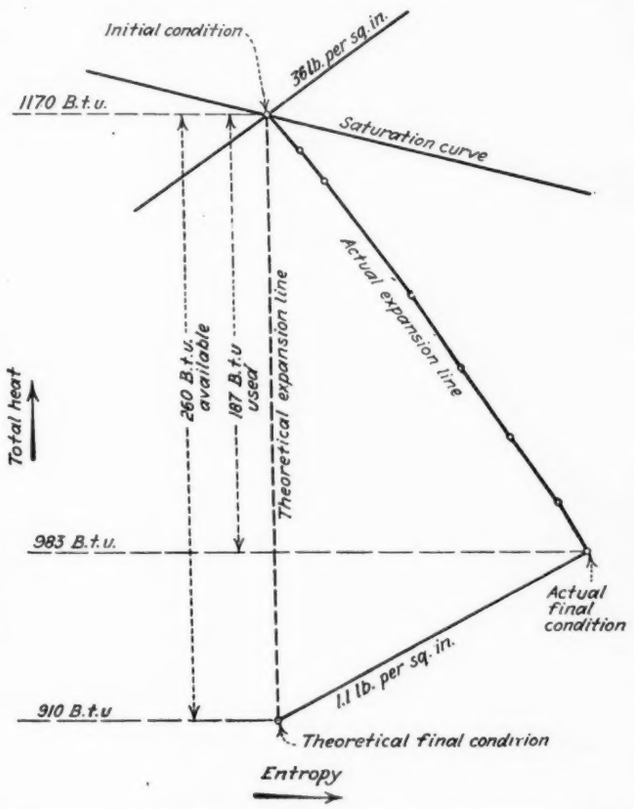


Fig. 1—The turbine efficiency over the range shown is 187 ÷ 260 = 0.719

In general this study has included proposals for two of the Fairmount station turbines, for which information was available that would permit of determining the internal hydraulic efficiency of the different stages of the machines. The test data included for the other machines has been of such detailed nature that the hydraulic efficiency of the different elements of these machines

*Mr. Quayle's address, delivered at the Spring meeting of the A.S.M.E., has only recently been reduced to writing. On account of its length the abstract has been broken into two parts, the first of which appeared in the Nov. 25 issue.

could be studied. This study has been summarized by plotting the expansion lines for all the machines on Mollier (total-heat-entropy) diagrams. The test data cover a vertical triple-expansion and a horizontal cross-compound pumping engine, a pure reaction turbine, a new special type of European turbine, and a Westinghouse-Curtis two-row impulse element.

To make clear the method of determining the efficiency from the expansion line plotted on the Mollier diagram, Fig. 1 has been introduced. The expansion line shown is for the saturation region only and represents the expansion from 36 lb. absolute down to 1.1 lb. absolute.

The expansion lines (*A* and *B*) for the Fairmount impulse turbines are plotted in Fig. 2 along with expansion lines for all the other units discussed. The European Erste Brunner turbine test results *C* are taken from a report made by Dr. A. Stodola, of Zurich, Switzerland. The test results *D* for the vertical triple-expansion pumping engine are from the official records of one of the Cleveland Water Department's Division station units. The test results *E* for the horizontal cross-compound pumping engine are those obtained on the official test of a recent installation for the City of St. Paul, Minnesota. The test results *F* for the pure reaction turbine are from the shop tests conducted

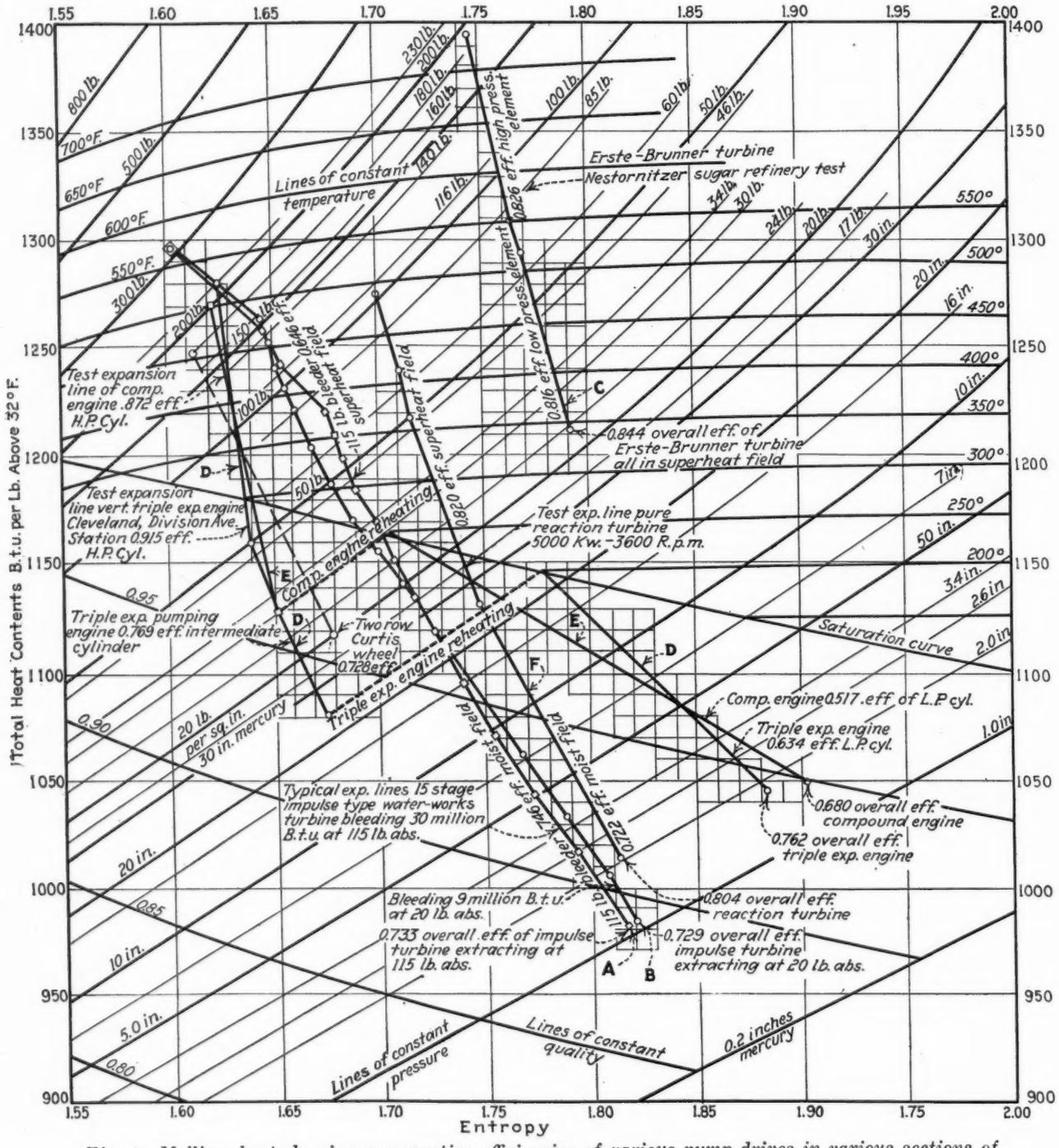


Fig. 2—Mollier chart showing comparative efficiencies of various pump drives in various sections of the expansion range

on a 5,000-kw. 3,600-r.p.m. Allis-Chalmers turbo-alternator unit now installed in the municipal plant of the City of Ashtabula, Ohio.

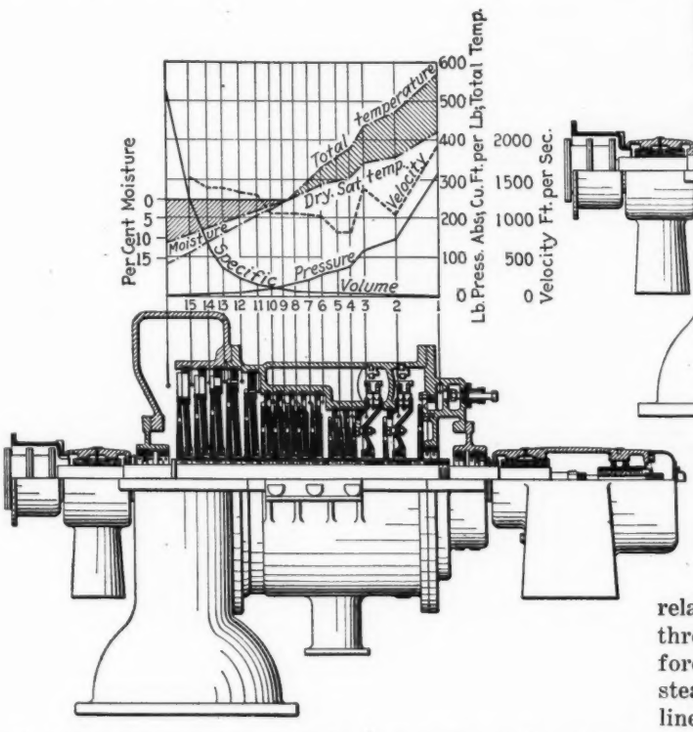
This study indicates that there is available to water-works engineers the possibility of an appreciable increase in the efficiency now obtained from the high-pressure stages or elements of the most generally used type of turbine in water-works service. It is a fact now rather generally understood that a steam prime mover is inherently more efficient when operating with steam superheated throughout the expansion range than when it employs moist steam. This means that other factors being made equal, a turbine or engine expanding steam from a condition initially superheated down through the moist steam field, should have a considerably higher efficiency in the superheat field than in the saturated or moist.

A study of Fig. 2 reveals that the reciprocating engines in the superheated field had the highest efficiency, it being in the neighborhood of 90 per cent. These engines, however, suffered owing to the inability of their low-pressure cylinders to expand the steam completely.

The special European machine (Erste Brunner) was brought out with a view to overcoming the loss in efficiency unavoidably present when a Curtis type of stage or an insufficient number of Rateau stages is used.

The expansion line for the pure reaction turbine is favorable because it will be noticed the test covered a condition of relatively low steam pressure. The expansion line of the reaction turbine can also be taken as showing very plainly the gain inherent in the use of superheated steam when other factors are maintained on an equal basis. The expansion line for this machine was obtained by observations of the quality of the steam at different stages throughout the expansion. The expansion line of the Erste Brunner turbine contains one observation of the quality between the inlet and exhaust. The turbine was two-cylinder and readings were taken of the steam pressure and temperature between the two cylinders. The engine expansion lines, especially the one for the triple, also show plainly the inherent gain to be realized by the use of superheated steam. The quality of the steam at the exhaust from the high-pressure cylinder and from the intermediate-pressure cylinder was obtained from the test data with a fair degree of precision so that the efficiencies given represent actual observed values.

The detailed comparison of the efficiencies obtained for expansion in the superheated and saturated fields for all the machines, as given in Fig. 2, shows the relatively low efficiency of the initial Rateau wheel through which a large heat drop is absorbed, and therefore run at an inefficient ratio between the blade and steam velocity. Considering the form of the expansion line for the proposed Fairmount machines and the test results of the Parsons type obtained with relatively low steam pressure, it is apparent that commercial turbines of the sizes under consideration have not been designed with sufficient stages to take advantage of the energy available in the high pressures and superheats of the steam supplied to them. It would seem as though the obtainable increase in economy would more than offset the increased cost of the additional turbine stages required to effect it.



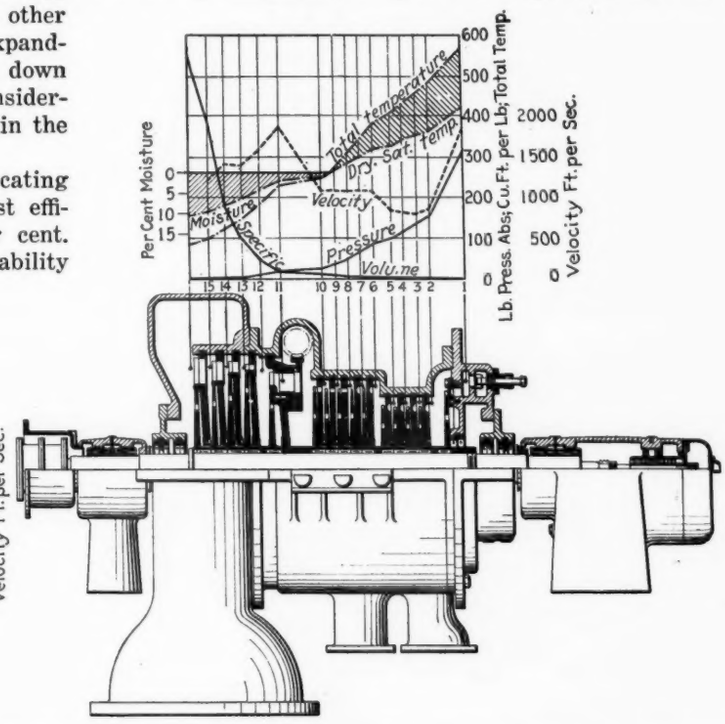


Fig. 3 (Left)—Typical cross-section of Fairmount turbine with high-pressure bleeding

Fig. 4 (Above)—Typical cross-section of Fairmount turbine with low-pressure bleeding

Only the very high over-all efficiency of the triple-expansion crank and flywheel type of pumping engine has made it a successful competitor of the cheaper types of pumping machinery, since it has always been at a great disadvantage as to first cost, and a somewhat lesser disadvantage as to the limited capacities in which it can be built.

It is therefore not surprising, in the light of the gradual increase in turbine and pump efficiencies that have been obtained during the last few years, that

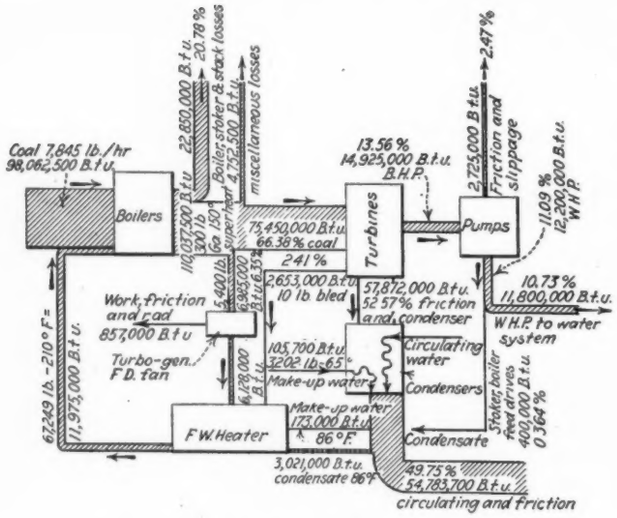


Fig. 5—Station heat balance in summer

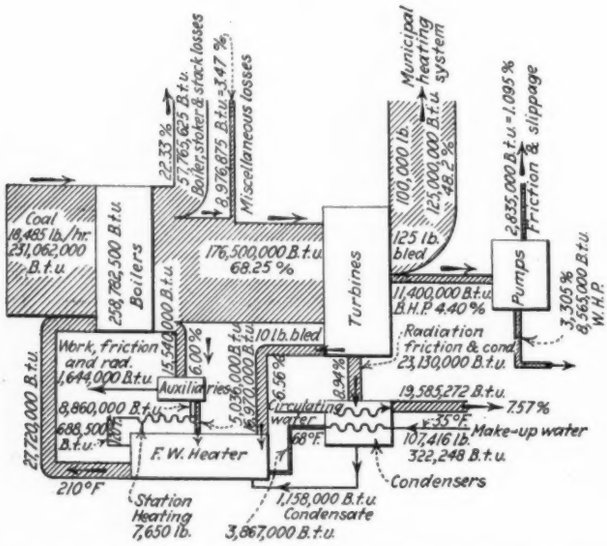


Fig. 6—Station heat balance in winter, bleeding steam at 125 lb. for municipal heating and at 3 to 10 lb. for filter plant

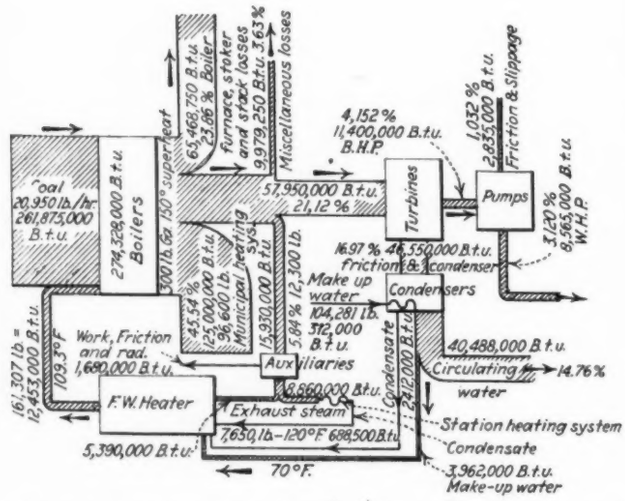


Fig. 7—Same as Fig. 6 but supplying municipal system from boilers through a reducing valve

water-works engineers can no longer afford to pay two and one-half times as much for a triple-expansion engine as for a turbine-driven centrifugal.

In order to visualize what these gradual increases in the turbine gear-driven centrifugal type of pump mean, we have computed the duty of a 30-m.g.p.d. pump of this type, working under a head of 250 ft., developing 1,315 w.hp., the steam conditions being the same as those which obtained on the test of triple-expansion Allis-Chalmers engine No. 4 at Division station, which we believe holds the world's record for economy, and find that a turbine gear-driven centrifugal unit can be bu"t from practically standard equipment which will have a guaranteed Rankine cycle efficiency of turbine and reduction gear of 72 per cent, a pump efficiency of 86 per cent, and allowing 2½ per cent for auxiliaries, will have a duty of 154.7 million foot-pounds of work per million B.t.u., compared with 173.8 obtained with the Allis-Chalmers engine at Division Avenue station.

The erected cost of the centrifugal type pumping unit would be approximately 40 per cent of the erected cost of the triple-expansion engine.

The foregoing comparison is made on the steam conditions of Division station, which were 220 lb. absolute, 520 deg. total temperature, and 28.2 in. vacuum, which as far as we know, are as high temperature and pressure as any engines of this type are now operating under. However, the turbine data are based on 29 in. vacuum.

It is a well-known fact that it is economical to build turbines for much higher temperatures and pressures than this, and for comparison's sake we have again computed the duty of a 30-m.g.p.d. pump operating under the same head and capacity conditions, but have assumed throttle steam of 500 lb. gage and 300 deg. superheat (total temperature of 767 deg.) and a vacuum of 29 in. We have also assumed that the turbine and pump builders allow their designers a free hand in designing for the best obtainable efficiency and that a turbine and gear having an over-all Rankine cycle efficiency of 79 per cent can be constructed as well as a pump having an efficiency of 88 per cent, and on this basis a duty of 200.5 million foot-pounds per million B.t.u. can be expected. From present reports on the value of reheating, a duty of 216 million foot-pounds per million B.t.u. could be obtained. This is the actual net duty deducting the extra heat required for reheating the steam. These duties include 2 per cent for the driving of auxiliaries.

Turbines and pumps of this high efficiency type would still cost only 60 per cent as much as the triple-expansion engine and have a duty as much greater than the triple-expansion engine as the triple-expansion engine is now better than the turbine. It would seem, therefore, that the future demand by water-works engineers for large triple-expansion pumping engines will be very limited.

Cross-sections of Fairmount turbines with high-pressure and low-pressure bleeding, with the correspond thermodynamic diagrams, are shown in Figs. 3 and 4.

The heat balance diagrams, Figs. 5 and 6, are given for winter and summer conditions for the station equipment as installed. Had the equipment for a straight condensing plant been purchased, the heat balance for such a station would be as given in Fig. 7. The loss from operating in this way would be large

Repair of a Wrecked Engine

By JOHN D. D. COOK*

OVERHAULING an engine is always a hard job, but when the unit has been wrecked by overspeeding, the amount of work is multiplied many times. Such was the situation with respect to a 525-hp. Diesel engine in a Canadian power plant after the 17-ton flywheel let go, part of the damage being shown in the illustrations.

This engine was used to carry the load during the day and up to 11 p.m.; a smaller unit helped to carry the peak load and continued in service after the large unit was shut down. The night the engine ran away, the small unit had been started up, synchronized into service and the 525-hp. engine taken off the line. To do this, the maneuvering valve on the fuel pump of this engine was shut, cutting off the fuel supply to the cylinders. Owing to the layout of the air lines, air at 900 lb. pressure may be discharged into the cylinder when shutting down. This apparently was the cause of the engine's speeding up until the flywheel gave way, wrecking the engine, crushing large openings in the building walls and damaging the generator as well as a second belonging to one of the smaller units.

A BREAKDOWN is something any engineer may face some day. Mr. Cook relates his experience with an English oil engine and the steps taken to repair the engine and generator in order to get them back into service quickly.

It will be observed from Figs. 1 and 3 that a portion of the wheel struck the generator stator. When this happened, the six 2½-in. diameter bolts of the shaft coupling sheared, permitting almost instantaneous stoppage of the rotor. Only four rotor and four stator coils were damaged.

The flywheel having left the shaft and the rotor disconnected, the engine was unbalanced and came almost to a sudden stop. It is hard to conceive the stresses that must have been set up in the crankshaft and connecting rods—in fact, in the whole of the engine.

This governor, which is mounted on the vertical shaft, flew into pieces and caused the thrust bearing to break also. This thrust bearing is fastened to the main frame of No. 1 cylinder, and naturally this breaking caused the top gear wheel to be out of alignment with the one on the camshaft, which caused breakage of the teeth and ruin of the shaft.

The reconstruction of this engine was interesting from many points of view, as owing to the nature of the accident it was necessary to test every part of the engine. Testing in a plant equipped with the necessary appliances is an easy matter, but in a power-house where the tools are inadequate, the work of checking alignments and renewing parts is vastly more difficult. The re-erection of the engine resolved itself into certain sections, such as dismantling, testing all working parts for flaws and torsional strains, erection and testing.

As the top half of the generator was smashed, a new section was ordered, the 6,000 laminations and 250 coils being removed from the old frame and put into the new part. The crushing of the stator frame led me to be anxious concerning the crankshaft and reciprocating parts of the engine. Having withdrawn the pistons, the crankshaft was tested for alignment by the use of a dial micrometer. The webs were very rough and difficulty was experienced to obtain accurate readings. A center was turned up to fit the micrometer, a drill of suitable size was ground to 45 deg. Centers were then drilled in the center line of the webs, ⅝ in. from the top; these were then a true fit for the dial point. This method gave accurate readings and showed the shaft was bedding in only two and a half bearings out of six.

To see if the shaft had not suffered torsional twist it was revolved in its bearings until the webs were horizontal; then, using a two-foot level, the webs were tested to see if they were horizontal. They were next placed vertically and the same test applied. This simple method would have shown at once if there had been any appreciable twist. The shaft was then gone over with a strong magnifiying glass for flaws, but in addition we used the much more accurate method of washing with kerosene the crankshaft, wiping it dry and then applying a thin coat of white lead. The shaft was then revolved in its bearings several times. Upon lifting the shaft any flaws would have been at once apparent, as the oil would have shown as a dark streak on the white lead. The hammer test was tried next, and the shaft rang perfectly true to the ear.

To test for twists in the crankpins, the webs were placed horizontal and a micrometer surface gage was placed on one web, and the point adjusted to touch the pin close to the opposite web. The gage was then removed to an exactly similar position on the opposite web, and had there been the slightest twist the micrometer would have shown the difference. A similar method was employed for the journals.

Owing to the lack of time it was not possible to remove the columns, and the crankshaft had to be bedded into its bearings with these in position. It was found that the babbitt of No. 5 bearing was badly cracked, and to save re-babbitting, the metal was fastened by means of screws countersunk into the metal, after which the countersinks were filled with white metal. The fillets of the thrust bearing were completely cracked through, and a new bottom half was fitted to allow an end play of 0.008 in.

Micrometer readings were taken between the webs as the rebedding proceeded. The necessity to make constant use of the dial micrometer gage cannot be too strongly recommended. Bedding in a shaft by the usual methods does not give an accurate idea of the shaft's trueness and a bearing may be out 0.006 in. or more.

Owing to the nature of the accident I had decided to fit new top and bottom end bolts in case the old ones should have elongated or twisted when the accident occurred. On taking down the pistons, considerable trouble was experienced in removing the gudgeon pins, one pin taking over three hours. There were no marks on the old bolts to show whether they had elongated or suffered any damage. It is always advisable to so mark the bolts that at future overhauls any elongation or twist may at once be detected.

* Superintendent, Light Department, Vernon, B. C.

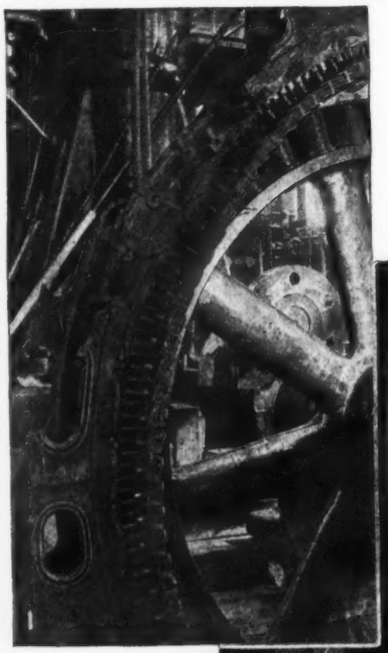


Fig. 1—Stator coils damaged but little

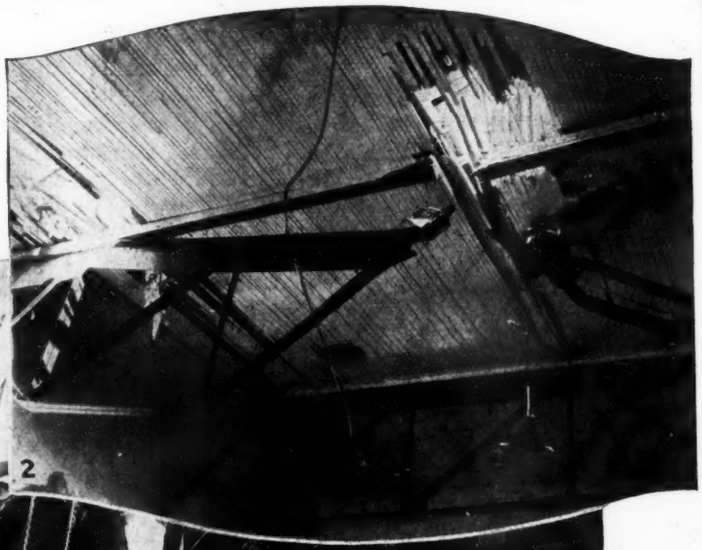


Fig. 2—Part of wheel went through roof

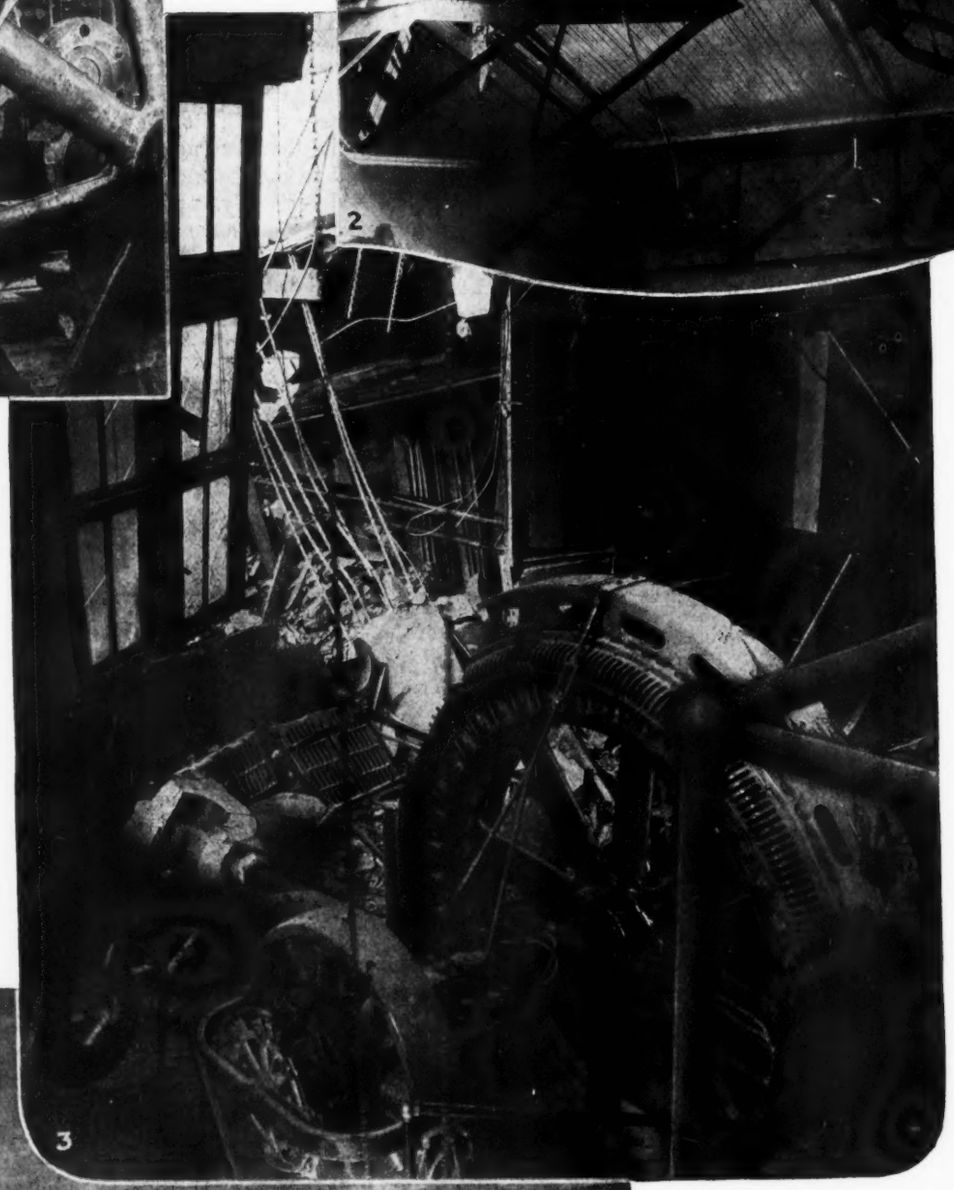


Fig. 3—General view of damage to machinery and building

Fig. 4—This part of wheel found 300 feet away

On examining the liners we found that with the exception of No. 4 all were in fair condition but much worn, and would need replacing at the earliest opportunity, which is not surprising since they had been in over ten years. The liner of No. 4 cylinder showed small flaws which appeared to be on the surface and which were evidently caused by a broken piston ring.

The new flywheel came in two parts. From the time the freight car was put on the siding to the time the wheel was bolted on the shaft, 28 working hours elapsed. The wheel had to be jacked up, put on a staging and lowered down a skidway. Each half had to be taken a matter of 200 ft. to the power-plant door, when it could be handled by the crane. It was an interesting job putting the wheel into the pit, because the total clearance between the crankshaft and the edge of the pit left only four inches, but by carefully tilting one half, it was slipped into the pit without even scratching the concrete.

Considerable trouble was experienced with all the new parts. This engine is about twelve years old, and evidently when it was built the firm had not thought of interchangeability or working to gage. As a consequence it was necessary to fit the parts the same as in a fitting shop, and a great amount of machining had to be done. No working drawings were supplied so the completion took longer than it would otherwise have done.

On completion the engine was started up on air to ascertain if everything was correct. It was then started up in the usual manner and allowed to run on kerosene for a short period, after which it was turned on to crude oil. Save for a slight adjustment of the main bearings little trouble was experienced. The engine was run light for a day to allow the main bearings and other parts to become settled, after which it was put onto the load, which it carried very satisfactorily, showing that in spite of the accident no apparent damage had been done to the working parts.

Advances in Stoker Design

By JOSEPH G. WORKER*

THE STOKER of today looks no more like the model of four or five years ago than the present automobiles like those of 1916. All automobiles have elements alike; that is, they have an engine and a chassis and a body. So does a stoker have a coal-feeding mechanism, a coal-burning structure and an ash-disposal mechanism. Stokers of ten years ago also had these elements, but development of these elements has been just as advanced as in the automobile.

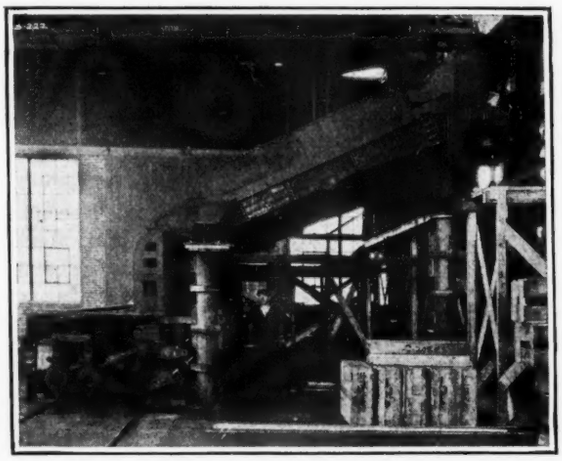


Fig. 1. Modern long multiple-retort underfeed stoker with rotary ash discharge

Compare a modern stoker of the underfeed type, similar to the design being installed at the new Kearny station of Public Service Electric Co., Fig. 1, with the short stoker of a few years ago. Fig. 2 represents a modern long stoker with a fuel bed laid out as near as possible to general operating conditions while Fig. 3 shows the short stoker of a few years ago. The point is that a combustion system must offer quite as much opportunity to the man who wants capacity as the one who wants efficiency. The long stoker has accomplished just that end. The short stoker on high capacity runs had to burn coal fast and get rid of the ash quickly as a single particle of coal had little time in the furnace.

*Assistant to President, American Engineering Co., Philadelphia.

To make this more clear, in Figs. 2 and 3 a block of 100 B.t.u. of coal is represented as starting at the fuel-feeding mechanism in the long stoker as well as in the small stoker. This block of coal is imaginably followed through from the point of entry to its discharge as refuse, drawn to scale representing the decreasing combustible content. With the small stoker about 4.2 per cent of the heat value of the coal is found in the refuse, while with the long stoker, about 0.4 per cent is in the refuse. This is the figure obtained on the Hell Gate tests, as reported in *Power*, Sept. 2, 1924. Assuming an eight-retort stoker of the underfeed type in both cases, the long stoker has two and a half times as much coal per square foot of projected area as the small stoker. The humps in the fuel bed of the latter are the direct result of trying to get high capacity on a short travel distance of the fuel. The characteristics of the two stokers can be summarized as follows:

MODERN LONG STOKER

1. More coal can be burned per foot of boiler front.
2. Great length of high-temperature zone.
3. Permits use of high and narrow boilers.
4. Permits more uniform thickness of fuel bed.
5. Higher efficiencies obtained at high ratings.
6. Coal is in furnace a longer period at equal ratings.
7. Allows greater stoker area to be installed under old boilers.
8. Provides better fuel bed conditions for high ash coals.
9. Fuel more completely burned out.
10. Lower stoker maintenance due to smaller percentage area of high repair zone.
11. Lower cost of installation.
12. Does away with double-ended stoker applications, therefore reducing power consumption and maintenance.
13. Allows entire lower row of boiler tubes to receive radiant heat, reducing furnace temperature.
14. Reduces the cost of a stoker installation per unit of capacity.

SHORT OLD STOKER

1. Low fuel-burning capacity.
2. Short zone of high temperature to burn out coke.
3. Necessitated wide boilers to get high capacity.
4. Operating conditions required hump in fuel bed (see sketch).
5. Lower efficiency at high capacity. Rapid drooping of efficiency curve.
6. Fuel in furnace a short time.
7. Combustible in ash run high at high capacity.

This long modern stoker of the underfeed type, as well as the long forced-draft chain grate, Fig. 4, has

realized some very definite performances that have made them successful and respected. They also have brought out a better realization of the interdependent relation between our heat generating processes and heat absorbing processes.

Now let us set forth the details of the aims of stoker development during the last year with some definiteness and briefly as may be.

1. Educational: We are aiming at a surer fundamental interpretation of what happens in the process of burning coal on different types of stokers. What causes clinkering of coals and what is the effect and loss due to coal clinkering? What difficulties are encountered in the development of devices for elimination of clinker adhering to an indefinite number of points? Is it easier to remove clinker from furnace walls or tubes than it is from the surface of a fuel bed or the walls of a furnace immediately at the surface of the fuel bed? What reason is there for presuming that a stoker cannot be designed to burn any kind of coal? What reason is there to believe that all operating difficulties cannot be minimized, if it pays to do it? Is it necessary to build the excessively high combustion chambers?

2. Efficiency: Why cannot higher thermal efficiencies be obtained on mechanical stokers than heretofore? This has partly been answered by tests on one of the boilers at the Hell Gate station with 92.7 per cent[1] combined efficiency.

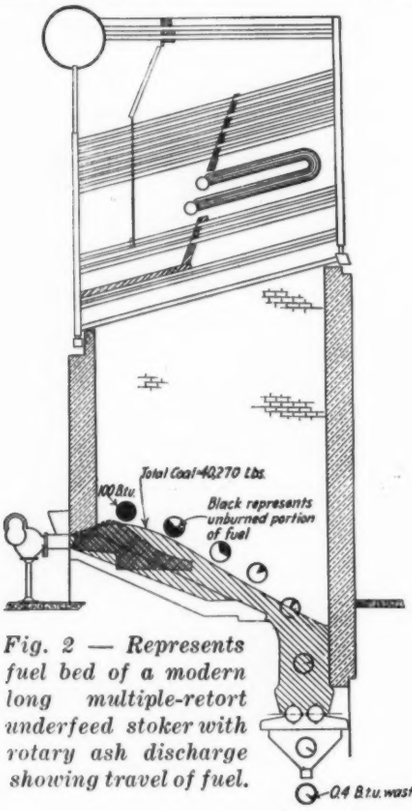


Fig. 2 — Represents fuel bed of a modern long multiple-retort underfeed stoker with rotary ash discharge showing travel of fuel.

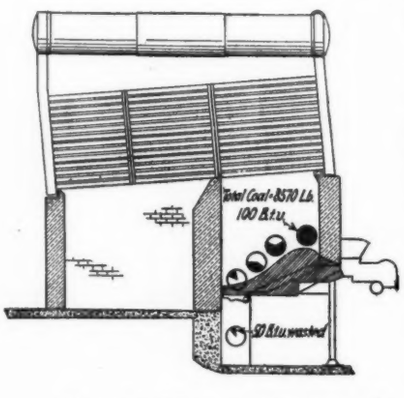


Fig. 3—View of the small stoker of only a few years ago about 8 ft. in depth drawn to same scale as Fig. 2.

3. Capacity: Many stations are being installed at present to operate at 300 per cent of rating, and on peaks it is possible to obtain on 378 sq.ft. of grate surface, under a 15,900-sq.ft. boiler, 603 per cent of boiler rating. This has been accomplished in 8,000 cu.ft. of furnace volume. A few years ago a 6,000-sq.ft. boiler had about 12 ft. 6 in. furnace width. The modern stoker has given over four times the capacity per foot of furnace width and eight times as reported at Hell Gate. This shows the development of stokers as far as capacity is concerned.

4. Banking Losses: What justifies the belief that coal must be wasted for banking and stand-by purposes on stokers? Already engineers have gone after this problem in a scientific way. Results will soon be published showing that where previously it has taken 3 or 4 per cent for banking and stand-by purposes, by new methods of banking and exercising care in sealing air leaks in setting and dampers, this figure can be reduced over one-half.

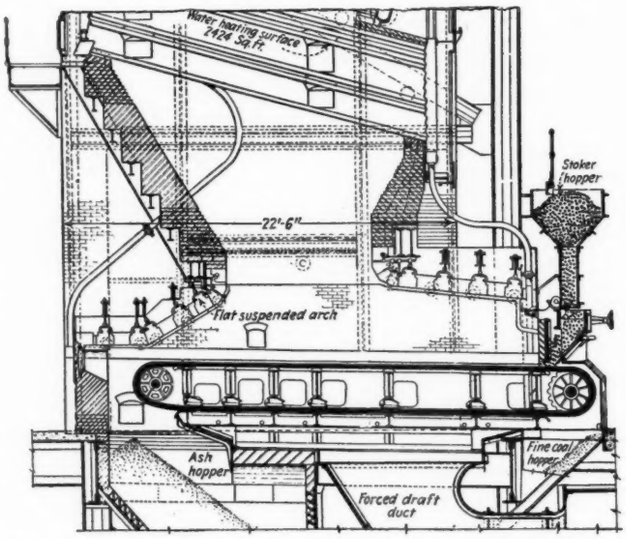


Fig. 4—Modern forced-draft chain-grate stoker application showing the recent development in connection with the application of arches at the rear of the stoker

5. Stoker Maintenance: Recent developments have made remarkable advances along the lines of reducing maintenance. Parts that were formerly heavy have been redesigned and made light but strong and maintenance should not be over one-half of what it used to be. Where formerly it was necessary to burn off bolts and chip off burned nuts, the modern construction provides easily removable keys.

6. Preheated Air: Stoker design will be ready for preheated air up to 500 or 600 per cent F. as fast as engineers favor it; already considerable work has been done. The Philadelphia Electric Co. is installing three types of preheaters and the stokers are being designed to handle air up to 600 per cent F. Special tuyeres will be used and a unique method of air zoning is contemplated.

7. Ash Handling and Disposal: With the introduction of the long stoker with the rotary ash discharge, the cost of handling stoker ash has been greatly reduced. One recent installation consisting of three boilers and two 20,000-kw. turbines spent only about $10,000 on a sluicing system of ash disposal. This system, of course, was made possible by the rotary ash discharge breaking up large lumps of ash into small pieces.

[1] It will be recalled that this efficiency was obtained on a boiler equipped with a fin type water-cooled furnace.—EDITOR.

8. Power to Drive Stokers: The large stokers for the Kearny station were set up in the shop and connected with a 3-hp. motor. When the power box clutch was in neutral position operating the stoker mechanism, the electrical input was 1.03 hp. When the stoker was running at low speed, the input was 1.19 hp. and when operating at high speed, was 1.33 hp. This was without any coal on the grates. It has been reported that the coal equivalent of the energy consumed by boiler auxiliary apparatus at Hell Gate, which included

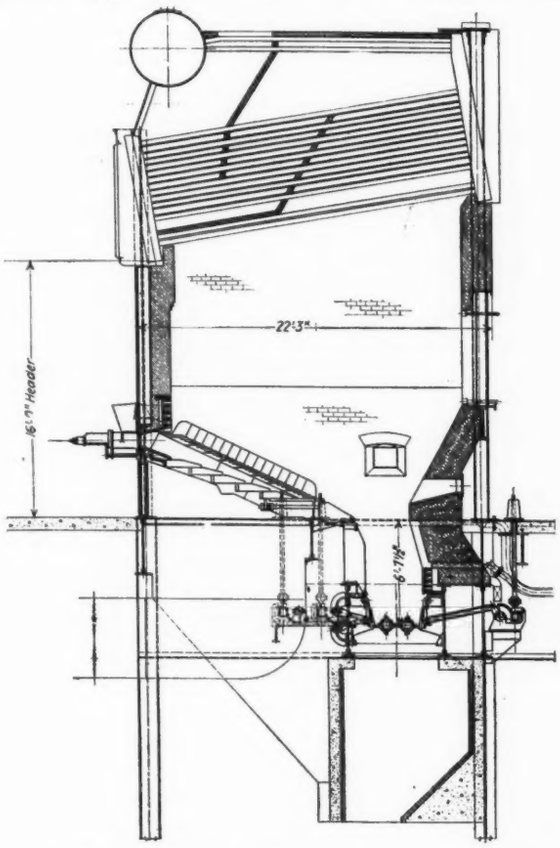


Fig. 5—Hydraulic underfeed stoker application for burning Middle Western high-ash coals with rotary ash discharge

induced draft and the forced draft fans, was 0.8 per cent of the coal burned during the tests. At the Philadelphia Electric Co., the power required to drive a 15-retort underfeed stoker and operating at 100 per cent of rating is about 2 hp. and when running at 300 per cent, about 4 horsepower.

9. Furnace Volume: The effect on efficiency and capacity that can be directly traceable to furnace volume is questionable, that is, when the furnace volume much over 4½ cu.ft. or less than 3½ cu.ft. per 10 sq.ft. of boiler heating surface. If the mixing of air and gases were better, exceedingly large combustion furnaces would not be necessary. Recent tests at the Waterside station have shown 15 per cent CO_2 on test boilers. The company engineers have been going through some interesting testing work to determine just what air admissions are best adapted to their conditions and have found that it is possible to so direct the entering air that the flue gas temperatures are greatly influenced by the air admission to the fuel bed.

10. Smoke: The liability to smoke on the modern stoker either of the underfeed or forced-draft chain grate, is considerably less than with the older type short stoker. The coal has a longer time to burn out the volatiles or smoking elements in the coal, and the burning is not hurried to the extent that smoke is produced. It is now possible to operate stokers up to 300 per cent of rating without objectionable smoke or in violation of the usual smoke ordnance.

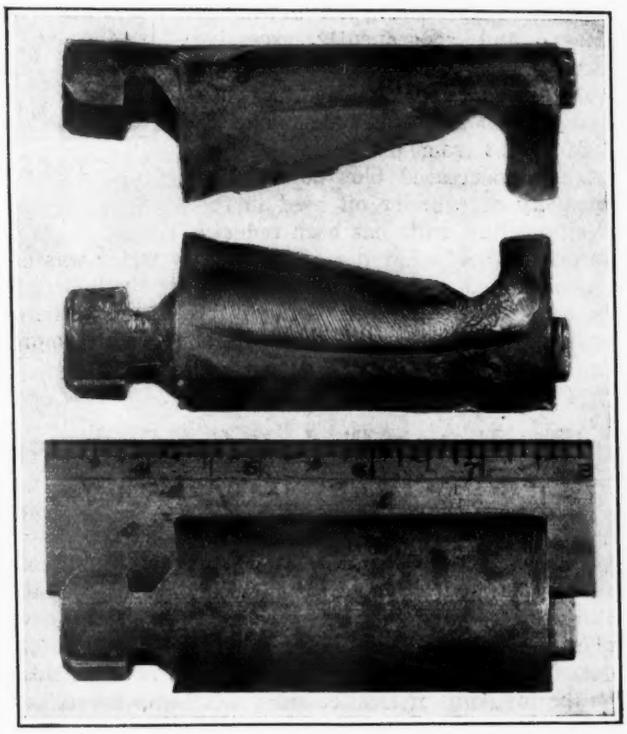
Dirty Feed Water Cuts Turbine Blades

By L. R. Wagner*

When the Department of Street Railways power plants were originally constructed in 1895, the population of the City of Detroit was 240,000 and the power plants were located near the eastern limits of the city. The equipment, as originally installed, consisted of four 1,500-hp. tandem-compound engines direct-connected to four 1,000-kw. generators in Station A, and two 1,000-hp. cross-compound Corliss engines direct-connected to two 800-kw. generators at Station B.

As the stations were near the outskirts of the city, the river water was comparatively free from contamination and the boiler feed was obtained by extending open flumes from the power stations to the river.

Since the original installation, the population of Detroit has increased to approximately 1,250,000 and these power houses are now in the heart of the city. There are many factories extending along the river



The upper two blades are badly worn, while lower blade is a new one

above the plants and numerous sewers have been constructed which empty direct into the river. The resulting waste matter, together with dirt from the city dirt-disposal dock, just a few hundred feet above the station intake, has increased the contamination of the river so greatly that the Department of Street Railways has experienced a great deal of trouble with foreign

*Electrical engineer, Department of Street Railways, Detroit.

matter being carried over into the generating units with the steam. As all of the engines are equipped with jet-type condensers, there was no possibility of using the condensate and consequently all feed water was taken from the river.

Recently, a 7,500-kw. turbine, installed in 1912, operated so poorly owing to bucket erosion, that extensive reblading was necessary. The photographs herewith show a typical blade and the excessive erosion that has taken place. This turbine was almost completely rebladed during 1919 and 1920.

About a year ago some extensive soundings and water analyses in the river just in front of the power plants were made in order to determine the feasibility of extending the existing flumes out into the river proper. The soundings and analyses indicated that no relief, in the form of purer water, would be obtained unless the flumes were extended some 75 or 100 ft. beyond the harbor line. This would necessitate a special conduit below the river bed in order not to interfere with navigation. Because of the large cost involved, the plan was abandoned and it was decided to install the necessary piping to use city water for boiler feed, which work was completed Aug. 1, 1924.

Besides eliminating the dirt in the steam and consequently excessive erosion of turbine blades and engine valves, the coal consumption has been reduced about 14 per cent dne to better heat transmission in the boilers and decreased blow-down. The quantity of cylinder oil used in the reciprocating units has been reduced to one-third of what it was before city water was used as boiler feed, and the amount of scale in the boilers has been cut down to an almost negligible quantity, thereby reducing boiler maintenance costs and greatly improving operation.

Hot Factory Finds It Can Generate Its Own Power Economically

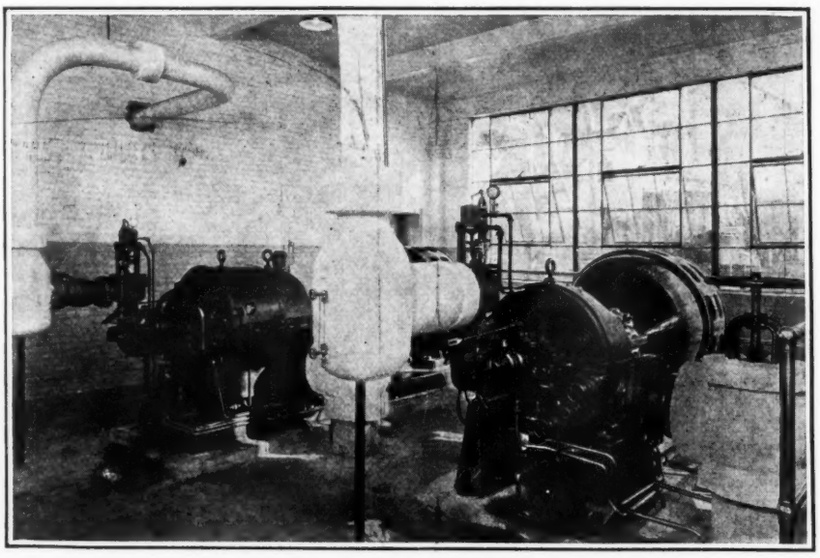
By F. A. Westbrook*

One of the most interesting features of the new factory erected by the Crofut & Knapp Co., manufacturers of hats, at South Norwalk, Conn., is the power plant, and the reasons why this company elected to generate its own power are an instructive commentary on the influence of local conditions.

In the felting processes large quantities of hot water are required to shrink the felt, and in other processes the felt has to be steam heated in order to shape it. There are several other uses for low-pressure steam besides. For these purposes it would be necessary to generate steam at about 70 lb. pressure in order to obtain it economically in sufficient quantity. Of course this means reducing valves which, in turn, mean inefficiency.

By using a steam turbine for a reducing valve, it is possible to obtain sufficient electrical energy to satisfy the power requirements of the plant at an almost negligible cost.

This is accomplished by generating the steam at 160 lb. pressure, and expanding it through turbines to 8 lb. before it enters the factory lines. There are two 450-hp. turbines, running at 3,750 r.p.m., geared to two 375-kva. 440-volt three-phase 60-cycle 1,200-r.p.m. generators. One of the turbines is single-stage and the other seven-stage. As the single-stage turbine requires and consequently delivers more steam, it is used in winter when the plant has to be heated. The seven-stage set, being the more economical of steam, is run in summer. Of course, in case of necessity, the 450-hp. turbine units may be easily operated in synchronism.



Two 450-hp. Terry turbines driving 375-kva. Allis-Chalmers' generators in felt factory

In this plant the exhaust steam from one unit is barely enough to supply the low-pressure steam requirements for the various processes throughout the plant, so that there is no waste. In other words, the only expenses properly chargeable against the electrical power are the carrying charges on the turbo-generator equipment, the space occupied by them and the excess cost of generating steam at 160 instead of 70 lb. pressure. This brings the cost of electrical power down to substantially less than it can be purchased for in that locality.

The success of the operation of sand filters for use with water depends upon the slow, regular flow of the water through the filter bed. As a rule the filter bed consists of a layer of very coarse gravel, say 8 in. deep, pieces 1 in. to 1½ in. in diameter on the bottom; next a layer 6 in. deep of ¾ to 1 in. in diameter; next a layer 4 in. deep of ¼ to ½ in. in diameter gravel; next a layer of fine pea gravel 4 in. deep and finally a layer of clean sharp sand 36 in. deep on the top. The water is led into the filter at the bottom and is taken off the top of the sand. It is very important that the rate of flow of the water should be low and uniform so that the beds will not be disarranged. The capacities of sand filters are usually designed for a flow not exceeding two gallons per square foot of filtering surface per minute. Great care should be exercised in washing sand filters.

*Consulting Engineer, New Canaan, Conn.

Miami Fort Power Station

Initial Two-Unit 80,000 Kw. Installation of Plant Designed for Six to Eight Units, Located on the Ohio River Near Cincinnati

THE new Miami Fort Station of the Columbia Power Co. now being built on the Ohio River twenty miles west of the center of Cincinnati and near the mouth of the Miami River, will be of exceptional interest in many respects, including as it does tandem compound turbines, special reheat boilers, economizers, air preheaters, stage bleeding and the burning of pulverized coal. An illuminating figure is the anticipated turbine water rate of 7.67 lb. per kilowatt-hour.

Designed for this exceptional economy, the initial turbo-generator installation will be made up of two 40,000-kw. machines, consisting of high- and low-pressure turbines in tandem, the high-pressure element to contain fourteen stages and the low-pressure machine twelve stages. Steam conditions at the throttle will be 550 lb. gage and 245 deg. F. superheat, giving a total initial steam temperature of 725 deg. F. The back pressure in the exhaust chamber of the turbine will be one inch of mercury, absolute. The design, however, will permit a pressure of 600 lb. and a temperature of 750 deg. F.

THERE will be six standard and two special reheat boilers equipped with economizers and tubular air heaters. The fuel will be powdered coal and the steam conditions 570 lb. gage and 740 deg. F. final temperature. Tandem compound turbines with reheating between the two elements and extraction from three stages will exhaust into vertical, inclined surface condensers. The anticipated turbine water rate is 7.67 lb. per kilowatt-hour.

Exhaust from the last, or fourteenth stage shell of the high-pressure element will pass to the reheat boilers at 120 lb., abs., 83 deg. F. superheat and a temperature of 424 deg. F. The steam will be returned to the first stage of the low-pressure element, at 110 lb. abs. pressure and at a temperature of 725 deg. F. When operating at full load without extraction and returning the leakage from the high-pressure packing to the twenty-second stage shell, the water rate given previously is anticipated.

EXTRACTION AND FEED WATER CONDITIONS

Heater	Per Cent Extraction	Pressure Lb. Abs.	Quality	Temp. Water, Deg. F. In	Out
Low stage.....	5.41	2.95	1.0 per cent moist	75	130
Intermediate....	2.80	9.70	77 deg. F. sup.	130	173
Gland.....	1.38	14.00	600 Deg. F. sup.	173	195
Open.....	2.61	40.00	240 deg. F. sup.	195	240

Extraction from the twenty-fourth stage will be utilized in the low-stage heater, which will be of the vertical, open type. The twenty-second stage extraction will be used in the intermediate feed-water heater of the closed type, with the steam space vented to the low-stage heater. Leakage from the high-pressure packing will be passed through a desuperheater to the gland heater and vented to the steam space of the intermediate feed-water heater. The eighteenth stage extraction will be utilized in an open feed-water heater located near the boiler room roof. The approximate quantities of steam to be extracted, the pressures and qualities of the extracted steam and the temperatures of the feed water entering and leaving the heaters will be approximately as given in the accompanying table.

In the boiler room the equipment will be six standard and two reheat boilers. Each of the reheat boilers, designed for 650 lb. pressure, will contain 6,060 sq.ft. of heating surface, a superheater containing 1,610 sq.ft., and a 17,275-sq.ft. reheat section mounted above and designed to take steam from the fourteenth stage of the turbine and reheat it to 725 deg. F. Each of the eight boilers will be equipped with a wrought-steel economizer and a tubular air heater.

Side walls and ashpits will be air cooled. The furnace volume will be 12,931 cu.ft. each. Burning 18,000 lb. of coal per hour of 12,000 B.t.u. per lb., the heat liberated will be 16,700 B.t.u. per cubic foot of furnace volume.

Pulverized coal will be the fuel burned. Per boiler there will be nine vertical and six horizontal flare-type burners and forty-five secondary air inlets. The air required for combustion will be heated by the tubular air heater and then passed through the side wall and ashpit passages before introduction into the furnace. The primary air will be heated by the ashpit passages and the secondary air in the side walls.

Five motor-driven triplex coal feeders will deliver the fuel to the burners. The ash will drop down into a sluice and be carried to a pit east of the boiler room, from which it will be removed by means of bucket cranes.

In the coal-preparation plant adjoining the boiler room the coal will be dried in two 6-ft. 6-in. by 50-ft. indirect pulverized-coal-fired rotary driers. The pulverizing will be done in six gear-driven screen-type mills, and the coal will be transported to the individual boiler hoppers by pneumatic pumps. The valves in the transport line will be electro-pneumatically controlled from a central switchboard.

Both forced- and induced-draft fans will be employed. High-pressure steam and boiler-feed valves, which will be of steel with forged Monel seats and disks and Monel stems and glands, will be designed in accordance with the 900-lb. standard.

Arrangements will be made to receive coal either by rail or by river. A concrete pier will be built in the river and extended above extreme high water to support a coal tower. The coal will be unloaded from the barges by a 4-ton bucket, with special alternating-current-direct-current control for the crane motor. The discharge from this bucket and also from the rail unloading hopper will be carried to a crusher tower by belt conveyor. Upon arrival here, the coal may be discharged to the initial storage pile, or crushed and dis-

charged to the belt conveyor leading to the coal-preparation plant. The coal discharged to the initial storage pile will be distributed over the storage area by means of a cable drag scraper. Crushed coal will be reclaimed to the crusher tower by means of the drag scraper, and run-of-mine coal will be reclaimed to the railroad hopper and conveyed to the crusher tower as before. The coal-handling system will have a capacity of 250 tons per hour. In storage there will be space available for 122,000 tons of coal piled 20 ft. high.

For the main turbines the condensers will be of the vertical, inclined, surface type containing 48,000 sq.ft. of tube surface, but with the tube sheets drilled to receive a maximum of 50,000 sq.ft., and the circulating water will be supplied by two 30-in. horizontal centrifugal pumps. The primary hotwell pumps will consist of two 6-in., two-stage centrifugal pumps, and the non-condensable gases will be removed by hydraulic vacuum pumps. There will be four nozzles per condenser, but only two will be required at any time. The hurling water will be circulated through these nozzles by two 8-in. centrifugal pumps. The equipment will also include a 6-in. sand pump.

By the primary hotwell pumps the condensate will be pumped through the generator air cooler to the low-stage heater and the discharge from the low-stage heater will return to the secondary hotwell pumps in the condenser pit. Two of these pumps will be supplied with each unit. Operating under pressure, the secondary hotwell pumps will deliver the water through the intermediate heater and the gland heater to the open feed-water heater near the top of the boiler room.

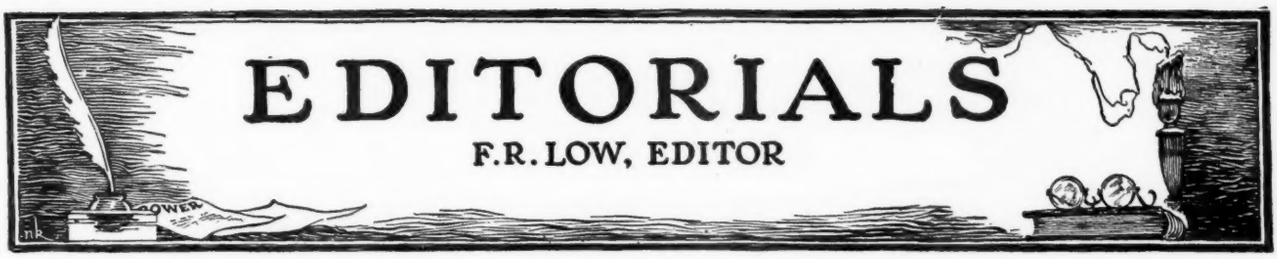
Water from the open feed-water heater will flow by gravity to the deaërators in which the pressure will approximate 15.6 lb., abs., the temperature of the incoming water 240 deg. F. and the outgoing temperature 215 deg. F. Normally, the con-condensable gases will be discharged to the atmosphere by the pressure within the deaërator, but two vacuum pumps will be provided and arranged to be cut in automatically if the temperature should fall below a predetermined limit.

The auxiliary generator and the exciter will be carried on the main generator shaft. Ventilating air for the main and auxiliary generators will be cooled by surface air coolers, those for the main generator having six main sections and six auxiliary sections while the cooler for the auxiliary generator will consist of one main section. The main sections will be arranged so that service water or condensate may be used as the cooling medium.

Sargent & Lundy, Chicago, are the designing engineers.

PRINCIPAL EQUIPMENT OF MIAMI FORT POWER STATION

Boilers	Babcock & Wilcox Co
Six standard boilers, sq.ft.	15,110
Superheaters, sq.ft.	2,640
Steam temperature at 570 lb. gage pressure, deg. F.	740
Two reheat boilers, 650 lb., sq.ft.	6,060
Reheat section, sq.ft.	17,275
Superheater, sq.ft.	1,610
Steam temperature at 110 lb., abs., deg. F.	725
Eight economizers, wrought steel, sq.ft.	7,300
Eight air heaters, tubular, sq.ft.	9,888.5
Furnaces, eight, 12,931 cu.ft. each	M. H. Detrick Co.
Pulverized-fuel equipment	Fuller Lehigh Co.
Burners flare type, 9 vertical and 6 horizontal per boiler	
Secondary air inlets, 45 per boiler	
Coal feeders, triplex, five per boiler, motor driven.	
Driers, two rotary indirect, 6 ft. 6 in. x 50 ft., pulverized-coal-fired.	
Mills, six 57-in., gear driven, screen type.	
Pumps, three 6-in. and two 10-in. Fuller Kinyon Valves in transport line electro-pneumatically controlled from central switchboard.	
Fans, forced and induced	Buffalo Forge Co.
Drive, motors	Allis-Chalmers Mfg. Co.
Coal unloading tower, 4-ton bucket	Mead-Morrison Co.
Crane motor control	Ward-Leonard—a.c.—d.c.
Coal-handling equipment: Rail unloading hopper, crusher tower, belt conveyors, cable drag scraper with tail blocks on motor—operated car	R. H. Beaumont Co.
Capacity—tons per hour	250
Coal storage, 20 ft. high, tons	122,000
Feed water heaters	Elliott Co.
Low-stage heater, vertical, open; intermediate heater, closed, 1,150 sq.ft. of surface, gland heater, closed, 1,020 sq.ft. of surface, high-stage heater, 18th stage, 40 lb. abs., open.	
Deaerators	Elliott Co.
Pressure within deaerators, 15.6 lb. abs. Water temperatures: incoming, 240 deg. F.; outgoing, 215 deg. F.	
Equipped with Nash-Hylor vacuum pumps.	
Boiler feed pumps	Ingersoll-Rand Co. A. S. Cameron Steam Pump Works.
Four 6-stage centrifugal, 400 g.p.m. against head 680 lb.	
Drive 400-hp., 2,200 volt., 1,800 r.p.m.	Allis-Chalmers Co. slip-ring motors
Two 6-stage centrifugal, 500 g.p.m. against head 680 lb.	
Drive, 340-hp. Terry steam turbines operating at 2,500 r.p.m.; steam conditions, 550 lb. gage, 725 deg. F., 10 lb., back pressure	
Turbo-generators	General Electric Co.
Turbines, tandem compound, 14 and 12 stages. Reheating between elements and extraction from three stages	
Steam conditions at throttle	550 lb. gage, 725 deg. F.
Back pressure	1 in. of mercury, abs.
Water rate, lb. per kw.-hr	7.67
Main generator, 44,705 kva., 3-phase, 60-cycle, 13, 200 volts.	
Auxiliary generator, 2,860., kva., 3-phase, 60-cycle, 2,300 bolt.	
Exciter, 270 kw., 250 volts.	
Generator air coolers, surface type	
Fire protection, inert gas in closed system	
Condensers, two, vertical inclined	Worthington Pump & Machinery Corp.
Surface, sq.ft.	48,000
Circulating pumps, two 30-in. per condenser; combined capacity, 60,000 g.p.m., 27 ft. head.	
Drive, G.E. squirrel-cage motors, 2,300 volt, 360 r.p.m.	
Primary hotwell pumps, two per condenser, 6-in., two-stage, each 800 g.p.m., 175 ft. head.	
Drive, G. E. 100-hp., 2,300-volt, 1,200 r.p.m., slip-ring motors.	
Secondary notwell pumps, two per condenser, 5-in., two-stage, each 800 g.p.m., 300 ft. head.	
Drive, G.E., 125-hp., 2,200 volt, 1,800 r.p.m. motors	
Vacuum pumps, No. 8 hydraulic, four per condenser	
Hurling water pumps, two per condenser, 8-in.	
Drive, G.E., 100-hp., 2,300 volt, 1,200 r.p.m., motors	
Sand pump one per condenser, 6-in.	
Drive, G.E., 60-hp., 2,300 volt, 900 r.p.m., squirrel-cage motor	
Traveling screens, eight, 82 ft. 6 in. vertical centers	Chain Belt Co.
Bucket crane, remove debris in front stationary grids	Whiting Corp.
Ice-melting pump, 48-in., vertical, 60,000 g.p.m., 15 ft. head	Worthington Pump & Mach. Corp.
Drive, G.E. squirrel-cage motor, 400 hp., 360 r.p.m.	
Crane, turbine room, 35-ton, traveling	Whiting Corp.
Valves, high-pressure steam and boiler feed, 900 lb. standard, steel with forged Monel seats and disks, Monel stems and glands	Lunkenheimer Co.
Cast-iron piping, cribhouse and condenser circulating water	Pittsburgh Piping & Equip. Co.
Receiver separators, supply line to each turbine	Babcock & Wilcox Co.
Electrical Equipment:	
Motor-generator sets	Westinghouse Electric & Mfg. Co.
Storage batteries	Gould Storage Battery Co.
Main switchboard and oil circuit breakers	Westinghouse Electric & Mfg. Co.
Circuit breakers, d.c.	Cutter Electrical & Mfg. Co
Disconnecting switches and choke coils	Champion Switch Co.
Transformers, 13,200 to 66,000 volts	Westinghouse Electric & Mfg. Co.
General:	
Substructure and tunnel work	Foundation Co.
Steelwork	Fort Pitt Bridge Works
Consulting engineers	Sargent & Lundy, Chicago.



Muscle Shoals and Power

OUT of the voluminous discussion on the floor of Congress and in other places regarding Muscle Shoals, there has come a picture in the average individual's mind of cheap power in large quantities for the people of the South and cheap fertilizer for the farmers of the whole country. This is a desirable accomplishment if it is commercially possible, but water-power projects in many cases have fallen far short of some of the earlier expectations.

Recent experiences have shown that it is not a question of how much power-generating capacity is installed in a water-power plant, but how continuous the water is going to flow. Machinery is of little use if nature takes a notion to cut off the water supply. It used to be considered that large storage capacity was an insurance against failure of water supply to hydro-electric plants. The experiences of the Southeast and the Pacific Coast have shown that storage may fail and cause great inconvenience to power users.

Muscle Shoals power developments are on a river where, up to the present time, little storage capacity has been developed, so that these plants will have to operate on run-of-river water. The flow of the Tennessee, like that of many other unregulated streams, varies through wide ranges. The minimum flow has fallen as low as 7,350 cubic-feet-seconds and the maximum has reached 500,000 cubic-feet-seconds. With the former flow under the head available at the Wilson Dam, now under construction, about seventy-five thousand horsepower can be produced, which represents the continuous power. The maximum flow is equivalent to over four and one-half million horsepower, but this is only for a short time. Even for the period of two and one-half months each year there is water available for only six hundred thousand horsepower. When the power project at Dam No. 3 is completed, these figures will be increased about thirty per cent.

Considering the present development at Wilson Dam, if one-half million horsepower is to be produced continuously, there must be some source to supply over four-hundred thousand horsepower for varying periods during the year. Whether the power is to be continuous or not during the twenty four-hours of the day, over four hundred thousand horsepower must be available from some other source, a considerable part of which must be from steam plants. A feature of the Muscle Shoals development that does not exist in many streams is that in low water if the load on the plant drops below that required for the total flow of the river, the water cannot be stored, since the navigation regulations require that the total flow of the river must be passed continuously when it gets below ten-thousand cubic-feet-seconds.

The foregoing are some of the obstacles in the way of Muscle Shoals becoming a great source of very cheap power. On the other hand, when the Tennessee River is fully developed, it is estimated that four billion kilowatt-hours can be produced in the two power projects at Muscle Shoals. This is equivalent to about ten per cent of the total power generated by all the central stations in this country last year. On the basis of one and-one-half pounds of coal per kilowatt-hour this power is equivalent to that produced by three million tons. These figures show that even though Muscle Shoals may not be the source of cheap power that has been pictured, it possesses great possibilities when demands develop for using large volumes of intermittent as well as continuous power. Such a source of power, if used wisely, can become of great economic value even if it may not be a hydro-electric bonanza.

Will Low-Temperature Carbonization Pay?

EVERY good citizen has a desire to see our natural resources conserved, but it is hardly fair to ask the individual to carry out conservation operations that are an actual loss so far as his personal pocketbook is concerned. However, this point is mainly academic, as few business men can be induced to operate in such a manner, whatever may be the altruistic view of the matter.

This is the case just now with the low-temperature carbonization of coal. Of the eighty million tons of coal carbonized per year in the United States about 90 per cent is treated by the high-temperature process, mainly to obtain city gas or metallurgical coke. The high-temperature process is of a destructive nature and "degrades" some of the rare oils and tars. Incidentally, high-temperature coke does not make a great appeal as a fuel to the average domestic consumer or small power plant.

"Low-temperature" coke contains a fair amount of volatile matter and is much better suited for domestic and small-plant use. The replacement of bituminous coal by such coke would practically do away with the smoke nuisance. This would undoubtedly be of great benefit to the community, but since the smoke and soot fall impartially upon the just and the unjust, only state or municipal subsidies could adequately reward those who thus benefited the community. The unfortunate fact seems to be that, for the present at least, the operator of a straight low-temperature process cannot ordinarily count on gross receipts exceeding four mills for the products of one pound of coal. This leaves him too small a margin for overhead, conversion costs and profit. With the present market, and under comparable conditions, he can get about four and one-fourth mills with high-temperature carbonization, the difference of one-fourth mill being due to the greater yield of gas and ammonia. Not only is the gross yield fifty cents per ton more for the high-temperature process, but the

conversion costs are generally lower because of more rapid treatment.

While these figures are comparative only and will change from month to month, as well as from district to district, the fact remains that they are not favorable to the strictly low-temperature process of distilling raw coal.

Many of these points were brought out in a recent address delivered by H. C. Porter at the Franklin Institute in Philadelphia. Doctor Porter stressed the probable advantages of combination low-temperature and high-temperature distillation processes, which he thought would raise the money yield per pound of coal above that obtainable with the straight high-temperature process. If such combination processes fulfill their promise in this respect, conservation may become more profitable.

Some Tendencies in Furnace Design

IN DAYS past the Scotch Marine and Lancaster boilers were prime favorites, but a high output per square foot of heating surface was impossible without a marked decrease in the efficiency. Someone evolved the theory that the presence of the water-cooled furnace walls chilled the burning gases, thereby accounting for the decrease in efficiency.

The development then proceeded along the lines of a boiler having a furnace of a large volume and with refractory walls, so that cooling disappeared and the gases had ample time to complete their combustion before striking the cold tubes.

Refractories have not proved an entire blessing, and cooling was imperative if clinkering was to be avoided and a reasonable life assured to the brick. ' Consequently, designers have reverted to the old water-cooled furnace and line the furnace sides with water pipes connected to the boiler proper, and no decrease in efficiency has resulted. The next step about to be taken, and it has already been made in several plants, is to reduce the furnace volume per square foot of grate surface, and apparently the reduction has not, and will not, impair the boiler's operation.

The problem that all have attempted to solve is actually that of obtaining a thorough mixture of the air and combustibles. While large furnaces may assist this in holding the gases until the union is completed, a large volume is not necessary, provided the air and fuel introduced into the furnace experience enough turbulence to give a thorough mixing; this applies more specifically to oil, gas or powdered coal as the fuel. This turbulence is obtainable if the fuel nozzle is correctly designed and the furnace is of such shape as to economize the turbulence. It is to be expected that furnaces will eventually depart from the present cubical shape and will be made somewhat cylindrical and considerably smaller than the maximum size now in use. While gas velocities through the furnace may increase, this is of advantage provided combustion is completed in the furnace. High rates of combustion are possible in relatively small furnaces; the locomotive may be cited as a case when rates are twice that existing in stationary boilers. This has been made possible by creating turbulence through the use of arches, and water-cooled walls within four feet of the center of the furnace so far have not been found to slow down the combustion.

The Flettner Ship

MARINE engineering lies a little outside of *Power's* normal field, but Flettner's "sailless" ship is an invention of such extraordinary novelty, as to warrant the explanatory article on page 1054 of this issue. Whatever may be the practical significance of this startling German invention, it at least has all the fascination of radio and cross-word puzzles, and commands the interest not only of marine engineers, but of all technical and non-technical men who like to see why the wheels go round.

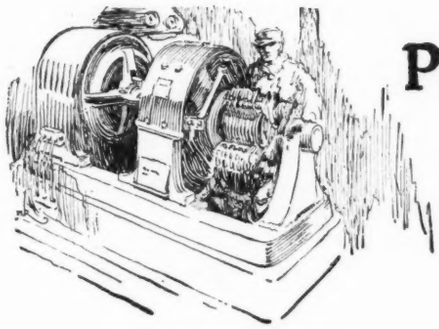
It is claimed that the Flettner cylinders have demonstrated an all-around superiority to sails having twelve times as much projected area. Such claims are always subject to checking, but it can at least be said that Herr Flettner is a scientific man who has attacked the problem in a scientific manner. Whether the new invention will revolutionize shipping remains to be seen, but it seems possible at least that it may become an important auxiliary on motor-driven tramp ships.

Many of the newspaper dispatches regarding Flettner's ship have made vague mention of stationary power plants being erected in Germany to utilize the Flettner cylinders for power generation. Regardless of whether such reports are authentic, as far as the theory is concerned, this might be done by substituting rotating cylinders for the vanes of the old-fashioned windmill.

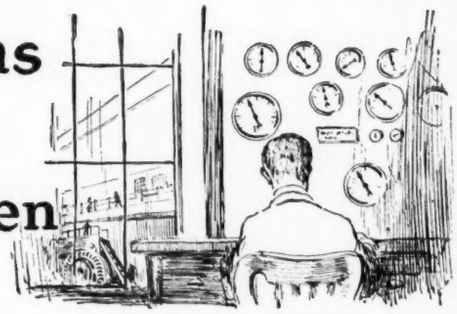
Wind power has been used for centuries to grind grain, pump water, etc. In rare cases windmills have been used to generate electricity. The high investment cost per unit of average capacity is only one reason why wind power is not more widely used for the generation of electricity. The other reason, perhaps the more important one, is the variability of the wind, which makes necessary a complete stand-by plant for handling the connected load during periods of calm. A location where the wind could be depended upon twenty-four hours a day and 365 days a year would put windmill power in a different light. With respect to this variability of the wind, a Flettner windmill would presumably be on the same basis as the older types. Whether it offers a substantial advantage in the matter of first cost remains to be seen.

That it is imperative to have more coal statistics has frequently been urged in the pages of *Power*. The classic illustration of the need for more good statistics is referenced to 1920 when a real shortage of coal was exaggerated greatly in the public mind. Had it been known at that time that after the critical period, which ended in June, stocks were increasing steadily, the frenzied buyers might have realized that the emergency had passed. As it was they did not know that stocks were increasing, and the disturbance of the market continued for months. In fact, it reached its peak in October, when stocks had climbed to the level of comfort. Statistics, authentic statistics with no ulterior motive behind their compilation, are greatly needed in the coal industry.

In any power plant supplying a number of services, such as a hotel or hospital, or several departments as in a manufacturing plant, the wise engineer will insist upon charging each department served as if it were an outside customer. In this way only can responsibility for departmental waste of heat or power be fixed.



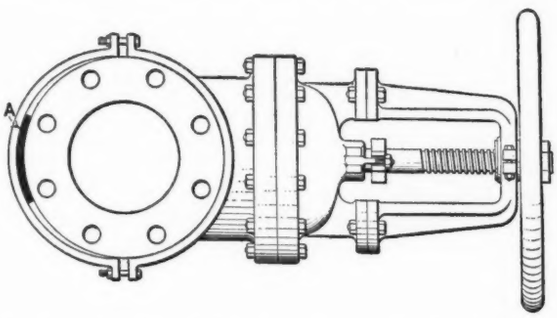
Practical Ideas *from* Practical Men



A Temporary Repair Job

A short piece of the gasket in one of the flange joints of a 6-in. gate valve blew out under 90 lb. pressure. A wrought-iron clamp was made to encircle the flange and to hold a piece of thick packing in place, as shown at *A* in the illustration.

It stopped the leak and held for two weeks, until there



Leak was stopped by clamping a piece of packing against the edge of the flanges

was a chance to insert a new gasket and thus make permanent repairs. This was better than trying to stop it with wooden wedges. W. H. WAKEMAN.

New Haven, Conn.

Valves in the Water Column

Many arguments for and against the use of valves in the water-column connections have appeared from time to time, but an accident occurred in our plant some time ago that convinced me of the necessity.

The accident happened one evening when I was hand firing a battery of return-tubular boilers. The electric light which hung near the water column of one of the boilers, had been moved during the day, and it was difficult for me to see the water in the glass. So I got a ladder and climbed up with the intention of tying a string to the lamp cord and pulling it closer to the gage glass. Somehow, I lost my balance on the ladder, and in falling I instinctively caught the first thing within reach which happened to be the pipe connection to the steam gage. This of course broke under my weight and since there were no valves on the connections to the water column to which the gage was connected, the boiler had to be taken out of service and the fire drawn. As I was the only fireman on duty at the time, I had to do this in addition to firing the other boilers. As the loss of this boiler threw considerable overload on the others, we had to cut off some lighting circuits until the load dropped down to a point where the boilers could carry the full load, whereas, if we could have shut off the column, the gage connection could have been repaired in a few minutes and the boiler kept in operation, thus saving an interruption in the lighting service.

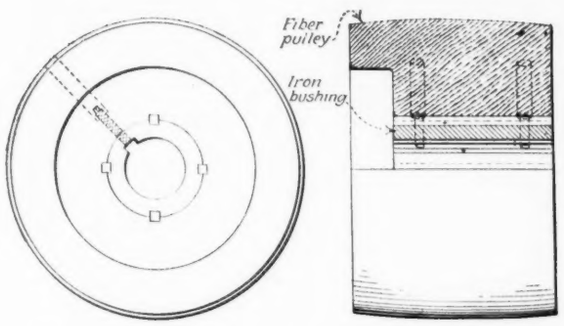
Brockton, Mass. FRANKLAND CHENEY.

Emergency Repair on a Motor Pulley

The method we used in refitting a pulley on a 50-hp. motor is illustrated herewith. Through carelessness on the part of the foreman in charge of the machinery the pulley had become loose, and this was not noticed until smoke was seen coming from the motor house. The motor was stopped immediately, but the pulley had to be removed from the shaft and refitted before the plant could be put into operation again.

The pulley was made of fiber and fitted with an iron bushing, having four ribs about one-quarter inch high on the outer surface. The bushing is driven into the bore of the pulley, and two setscrews that pass through the pulley and bushing and seat against a key in the shaft, serve to hold the bushing from moving lengthwise in the pulley. The fiber around the bushing had worn so badly that the bushing was entirely loose, being held only by the stubs of the setscrews, which had also broken off. The job of repairing was turned over to me, and after a search around town for another pulley I decided to refit the old one on the shaft.

Having several good toolmakers at hand, I directed one to bore the pulley out a little larger than the burned



Shows method of securing bushing in pulley

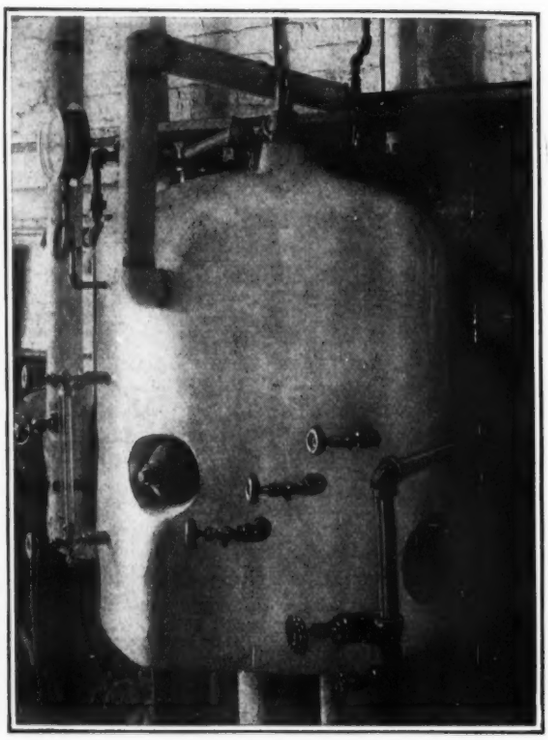
bore in order to provide fresh material around the bushing. To another I delegated the task of making a new iron bushing somewhat larger than the old one and with outside dimensions to conform to the bore of the pulley. Four keyways were cut in the outer surface of the new bushing and in the pulley as shown in the illustration. When this was done, the four keys were secured in the bushing and the bushing was then driven into the pulley. C. C. HERMAN.

Waterloo, Iowa.

Small Electric Steam Boiler Replaces Coal-Fired Type

An interesting application of an electric steam boiler, shown in the figure, was made some time ago in a small manufacturing plant where fruit products were cooked. The process required steam at 70 lb. pressure under an intermittent load. The location was not suitable for a small coal- or a gas-fired boiler, so an electric boiler was installed. This boiler is so designed that a large steam space is left above the water, and submerged heating units are used to transmit the heat to the water. It was necessary to carry a small amount of water in the unit so that it would act very much as a flash boiler.

The heating elements consist of 50 kw. divided into five 10-kw. units, each unit being a double hairpin.



Electric steam boiler of 50-kw. capacity

Forty-five kw. of the power is connected to a pressure-control switch which cuts out at 70 lb. and in at 62. One-half of a 10-kw. heating unit, or 5-kw. capacity, is in service continually to take care of radiation losses, and this keeps the pressure about constant when only small amounts of steam are being used. The boiler supplies three steam-jacketed kettles; the minimum consumption of steam is about 120 lb. per hour. The condensation is returned to the boiler through a trap, therefore very little makeup water is necessary.

Steam for this installation was previously supplied by a fuel-fired boiler in a neighboring building which was abandoned. This supply was metered at the basement, which of course included all the heat losses through radiation between the basement and the fourth floor, where the electric-boiler installation is located, which amounted to a considerable item. The advantages derived from the electric boiler are that the owner has 24-hour service under his control, the labor element is eliminated, and no dust or fumes have to be contended with, such as would be present with a fuel-fired boiler.

This boiler is of special construction, designed for this application by the writer and J. L. Faden, of the Edison Electric Illuminating Co. of Boston, and built by the International Engineering Works, Framingham, Mass.

D. J. STUMP.

Framingham, Mass.

Buying Power-Plant Equipment

Some thirty years ago, when I was employed in a large works, the superintendent, a canny old Scotsman, gave me the following advice: "Terry, if you want to be a successful engineer never let any man sell you anything, not even a spanner; always buy it."

Things have changed in the power world since this advice was received, but so far, I have not found my old chief's advice very far wrong. On the other hand, I have seen many men get into serious trouble who, either through ignorance or carelessness, allowed someone to sell them something. One of these I remember was a very clever engineer, who, probably owing to a certain amount of sea experience, did not think it any part of his work to worry himself about new equipment. He preferred to let his superiors purchase any equipment they fancied and he would look after it. Naturally, it was not long before the trouble began and my friend found himself replaced by a man who could tell the firm what they wanted to know about equipment.

There are, I am sure, many such engineers to be found. They never have time to read a trade journal or an advertisement, consequently, any kind of material can be passed on to them by salesmen who come along. If they are asked for an opinion, they never condemn anything because they cannot give reasons, and all the information you can get from them is that it is all right as far as they know.

Talking this matter over a few days ago with an old friend who has spent most of his life as sales manager for a large firm of power-plant equipment manufacturers, he informed me that he was never happy when he had to sell anything, principally because he never knew whether his goods would have a chance. He said: "When I go into a superintendent's office and see a few trade journals lying about, I at once realize that if this man buys I will make a friend and that our advertisement has done its work. Only the other day I was over seeing Jones about a small turbine and got the surprise of my life. I thought he knew nothing about turbines, and I went prepared to enlighten him, but he did the enlightening. He showed me articles and advertisements on a great many turbines and finished up by telling me why he was buying ours."

With the facilities available today it is much easier for all superintendents to be in the position of Jones than it was thirty years ago. Trade journals give all the latest news and advertising is much more reliable and general than formerly, and the superintendent who relies on having equipment sold to him instead of buying it should not be surprised when he is replaced by a more progressive engineer.

F. P. TERRY.

Belfast, Ireland.

One of the secrets of successful operation of any type of CO_2 recorder is keeping the joints in the sample lines tight. This may often be done by the liberal use of shellac.

Comments from Readers

Standardizing Ammonia Fittings

The article by R. G. Summers in the Nov. 18 issue brings to the front a condition that has caused refrigerating engineers and construction men a great deal of confusion and loss of time. There are so many different makes and patterns of ammonia fittings on the market that it is impossible for the engineer in charge of a plant to remember them all and to know which are interchangeable and which are not. For some unknown reason the manufacturers of ammonia valves and fittings have failed to get together and set a common standard for their products, as have other manufacturers.

However, the use of the oxyacetylene welding and cutting torches has done much toward simplifying the construction and repair work on ammonia piping. In most cases where changes in piping are to be made, it will be cheaper to cut and weld the pipe in place, using long-sweep pipe bends and welded outlets in place of flanged or screwed elbows and tees. A great deal of time may be saved, as the pipe can be cut and welded in much less time than it takes to cut threads, screw on flanges and make up the joint. In plants isolated or a long distance from a point where fittings are carried in stock, the welding method seems to be the logical one to use.

Welded piping not only presents a better appearance, but in the case of low-temperature piping the insulation cost is considerably less due to the elimination of special covering over flanges and fittings and to the lessened labor required in insulating straight-run piping free from flanges and fittings. Long-sweep bends are easily covered by cutting standard covering to bevel, and outlets by cutting the section of covering on the outlet to fit the shape of the main-line covering, a comparatively simple operation. The entire insulating job may be done with straight sections of covering, no special coverings for elbows, flanges and fittings being required.

The objections raised by engineers, owing to lack of standardization of valves, still remain to be cleared up, however, and it is hoped that the manufacturers in the near future will be able to get together and decide on standard sizes for their products. H. N. ROYDEN.

Los Angeles, Calif.

Fitting Piston Rings by Peening

Following up the subject discussed by Mr. Cowles and Mr. Belknap in the issues of Oct. 21 and Nov. 18 respectively, entitled "Fitting Piston Rings by Peening," I believe that there are several methods of bringing piston rings to a fit that have not been touched on.

The custom of peening piston rings for correct fitting is probably more of an emergency measure than it is modern construction, and while it may be successfully performed by some engineers or mechanics, it is no longer considered the best practice.

Re-turning the rings after cutting from the blank as shown by Mr. Belknap's drawing and description, is in line with the practice of many shops, although the method of holding the ring varies.

The practice of turning the ring to a fit has been replaced in many shops by that of grinding off the surplus metal after the ring has been cut and expanded to an oversize.

The more modern method of fitting snap rings is the electrical heating and pressure system, which in reality is a heat treatment of unusual care and exactness. In this system the rings are cut oversize in the rough and ground to a fit for the cylinder in which they are to be used. A number of the rings are then placed in a false cylinder of the exact size as the one on the engine. This false cylinder is equipped with cooling arangements so that, when once heated, the outer part of the ring may be cooled sooner than the inner part. The rings are heated by an electric fixture, and when at the proper temperature a pressure of several tons is applied to their inner surfaces. The action of the device gives the ring a permanent set for expansion, yet when sprung to the cylinder walls, it is as near a perfect fit as modern practice has been able to make. The cost is not great in this method, and the personal equation of accuracy is less depended on than in the machine-finished ring. The grinding practically fits the ring to the cylinder, although certain inaccuracies are corrected by the heating and pressure system.

The stress on the grain of the ring is not confined to the inner surface, but is distributed through the whole cross-section as well as throughout the entire circle of the ring. This insures a more constant fit of the ring even though misused by faulty lubrication or other heating. The grain is more nearly uniform for wearing, and as a whole the ring will give better service. WENDELL MITCHELL.

Rogers, Neb.

Indirect Radiation To Heat Combustion Air

The editorial in the Nov. 18 issue entitled "Using Indirect Radiation To Heat Combustion Air," brings up a subject that many engineers have been studying for considerable time. In plants where indirect heating equipment is installed, it is generally used for ventilation as well as heating or for the purpose of conditioning the air.

Frequently, steam humidifiers or water atomizers are used with the manifold coils to increase the humidity, to prevent stocks in process of manufacture from becoming too dry. Where this is done, the air is too moist to use for combustion purposes even if the velocity at which it entered the boiler furnace could be properly regulated to maintain even furnace temperatures to meet the varying demand for steam.

Isolated plants of large size seldom use more than four or five boilers of 5,000 sq.ft. of heating surface

each and in a plant of this size the ventilating and heating equipment is easier and cheaper to operate when in a compact unit in the steam plant, than it would be if separately operated and scattered about the buildings.

The great trouble in using air from these fans for forced draft is the enormous size of the heating and ventilating fan, requiring varying speeds to meet weather conditions and the different velocities at which the air is delivered to the stacks for distribution at different times of the day. During the morning hours in cold weather the fans are usually run at maximum capacity and from 10 a.m. to 3 p.m. at minimum capacity, then speeded up again during the evening. If a fan was operated at the same speed continuously, some of the air could be used for combustion and the draft regulated by the damper in the air duct to the furnace, the ventilating stack diverting the air from the building to the furnace and vice versa as required. This would cause a varying temperature in the different rooms, which is to be avoided if possible.

These ventilating fans are usually large, being around 40,000 cu.ft. capacity and often require an 8x9-in. engine or a 20- to 30-hp. motor to drive them, which is a much larger unit than would be required for forced draft on the boiler. Hence, many plants install separate fans for forced draft and use cheaper grades of fuel and often shut down their indirect radiation fans during the summer months or shut the steam coils off and use cold-water coils to cool the air in the buildings below the atmospheric temperature.

In the last few years the uncertainty of coal supplies has led to the installation of oil-burning furnaces to such an extent that many buildings that had used coal and forced-draft fans are now using oil. The use of oil eliminates dust to a large extent, improves the ventilation, allows a greater storage capacity in a smaller space, and the steam atomizing burner requires no force-draft air from ordinary installations, though in some large plants air is used for atomizing in place of steam. The air for this purpose is of higher pressure than is obtainable with the forced-draft fan and is supplied by a special blower or from an air compressor.

Cambridge, Mass. R. A. CULTRA.

New Design of Semi-Diesel Engine

The oil-engine cylinder shown in the illustration may be considered as a supplement to my comment on "Diesel Engine with Precompressor and Exhaust Turbine," appearing on page 854 of *Power*, Nov. 25.

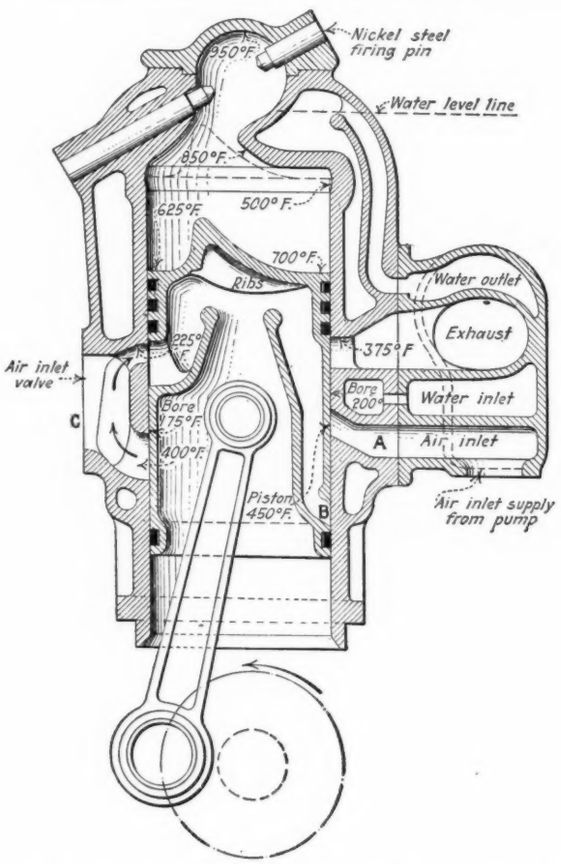
The cylinder is unique in that the piston receives the total air volume which is delivered at the inner end, so that the flow is downward while the piston is on the upstroke, and during the transfer of air to the combustion space the flow through the piston is upward. This tends to reduce the temperature of the piston head and skirt; it also eliminates the transfer of crankcase oil vapors by avoiding the cause.

The delivery of the major portion of the air entering the crankcase is at the air-inlet valve *C*, being due to the piston displacement, which is later supplemented by a supercharge by means of the ports *A* and *B* at the extreme end of the pumping stroke.

This means that the low pumping efficiency of the usual two-stroke-cycle engine is improved by the delivery of this auxiliary air under pressure by means of a pump of such capacity as to assure an air volume sufficient to scavenge the combustion space.

The delivery of both air volumes well up on the cylinder bore means that any heat absorbed by the air will be regenerated into useful work instead of leaving the engine by the jacket-water route.

The combination manifold shown at the right side of the cylinder is used to complete the destruction of exhaust heat by its contact with the water about to enter the jacket. In the marine engine the tempering effect of cold water is not only advisable, but it is essential where care is taken to avoid abnormal local cooling of any part of a cylinder bore. The heat balance is again improved by the jacket water absorbing exhaust heat, so that heat that would otherwise be lost is again regenerated. The discharge of the jacket



Two-stroke-cycle engine with air cooling of the piston

water on top of the exhaust pipe is useful in eliminating hot pipes, noise and back pressure.

Hot surfaces are a menace, so it is considered advisable to use every means to destroy the cause of disastrous fires by a combination of results all tending to improve each other.

The value of an air-cooled piston is best explained by adding a few figures to show what the temperatures are in the usual uncooled designs. The temperatures of the hot bulb must be maintained at 950 deg. F. to cause ignition, but there is no reason why the piston head should be 775 deg. F., nor does it improve the shape of the bore to have so wide a variation in temperatures as shown.

It is not suggested that uniform temperatures are possible owing to the design shown; perfection may never be attained, but ideal conditions can at least be aimed at. A hot bulb is essential to ignite the oil charge, and a hot piston is too often a disastrous assist-

ant and a costly detail to replace when it is fractured, while both may contribute to a wrecked engine. An overheated piston is never advisable, as it may swell sufficiently to score the cylinder; oil is of little use in preventing scoring, as this lubricant is destroyed by the abnormal temperatures. The transfer of crankcase oil vapors to the combustion space may permit the engine to show a low fuel consumption, but this is at the expense of the more valuable lubricating oil. In my engine design this condition is not considered possible, as oil vapors must pass the upper end of the piston before they can enter the cylinder.

JAMES MCINTOSH, PRES.,
Cleveland Ohio. The McIntosh Engine Co.

Boilers for Heating Purposes

The opinions expressed by Egbert Douglas in his article in the Nov. 18 issue coincided so well with my own ideas and with what I have advocated during the last five years, that I feel it a duty to continue the discussion. I believe that more facts such as Mr. Douglas gave should be carried to the designing engineers and architects in order to break up the prejudice against the use of high pressure for heating systems.

During the cheap fuel age of the past the heating plant was a secondary consideration. Like the fireplaces of the colonial homes, they must be of ample capacity to afford comfort although the amount of fuel consumed was exorbitant. But with the advanced cost of fuel and the magnitude of the heating question the methods of heating have become factors that determine greatly the profit or loss of the investment.

During the last five years my work has thrown me in contact with the managements of large hotels and other large buildings, and I have discussed the problem of heating with many engineers. There seems to be but little understanding as to the relative efficiency of the high- and lower-pressure systems among the managements, the owners or even the engineers of the buildings.

The argument in favor of the low pressure is, invariably, that they believe there is less trouble with the low-pressure system than with the high, meaning by less trouble that there would be less leaks, less danger of damage from all leaks and that the low pressure is the easiest handled. These excuses, as well as most others given, have little arguing value to one familiar with the high-pressure system.

The whole problem is probably one of evolution as has been that of the steam power plant. It must be remembered that for more than fifty years after it was known that high-pressure systems for power plants were the more efficient and practical, we continued to install and use the wasteful low-pressure systems. Not until we were forced to conserve space in our large plants did we finally consider the high-pressure systems.

To the investor as well as the architect the long-used low-pressure system may seem the surest, and to the contractor it is as profitable to install as the high-pressure and requires perhaps less skill. The space for installation is usually ample or may easily be so designed. The comparison with similar buildings in heat costs are usually based on the efficiency of the low-pressure systems; thus, to the management not understanding the difference between the two systems, the fuel cost of his building is apparently not more than what is considered good practice.

Municipal buildings perhaps have fewer installations of high pressure in comparison than do privately owned buildings, and large buildings constructed during the war are largely equipped with the low-pressure heating systems. In one of these buildings that I had occasion to investigate I found even greater extravagance in heating capacity than Mr. Douglas has mentioned. There was 42 per cent more capacity than modern practice allows even after allowing plenty for reserve.

But this is not so important as are the wasteful systems where by their combined consumption millions of tons of coal are consumed each year, which, if saved by modern economical practice, would go far to relieve future generations of fuel shortage.

There are probably no buildings where more heat is wasted than in hotels and apartment houses. In these buildings, particularly, there should be installed every modern heat-saving system and appliance which have proved practical.

As power rates advance, for lighting and other prime-motive use, which they are likely to do, the individual building power cost, when purchased from an outside source, will advance more in proportion than at present; that is, when considering that the individual building is large enough to operate its own power plant economically and that the steam-generating part of the plant is already a part of the building and that a good part of the labor for the power plant is necessary for the heating plant. But unless the boiler capacity is such as to make it meet the demands for the power requirements, the economy of individual power-plant installation cannot be taken advantage of.

There is no reason why the engineering part of modern architecture should fall behind modern engineering, and so long as it is a matter of economy that affects not only the present but the future generations, it becomes the duty of the engineering world to bring about the changes that will modernize the system.

New York City. G. G. MCVICKER.

Chain Grate vs. Underfeed Stokers for Lignite Coal

Referring to the letter of G. B. Thomas on page 852 of the Nov. 25 issue, I think he will find on detail investigation that the multiple-retort underfeed stoker of the level fuel-bed type is preferable for his conditions.

With a stoker of this type the coal flows to the rear in a steady even travel without surface agitation, an action similar to the chain grate. It has this advantage: It gives complete control of the fuel bed so that the fuel may be fed faster to one portion of the bed and slower to another. Therefore, should a thin spot develop in one portion, it can readily be built up, while at the same time a higher spot in another portion is being carried away. The tuyeres of this particular stoker are designed especially for lignite.

By using underfeed stokers and forced draft, much higher ratings can be maintained, less boiler equipment is in use and there is less preventable loss of combustible in the ash. ROBERT JUNE.

Detroit, Mich.

A cloudy coating of powdered graphite applied to the surfaces of a gasket in the joint of a pipeline will facilitate its removal as well as installation when the joint is broken and remade.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Advantages of Center-Crank Engine

What are the advantages and disadvantages of a center-crank engine? *F. G.*

The main advantages of a center-crank engine are compactness, small floor space, and reception of crank pressure on two shaft bearings in place of one overhung main bearing as in a side crank engine. The disadvantages are requirement of a better foundation support, inaccessability of crankpin and connecting-rod bearing for lubrication, difficulty of aligning and leveling crankshaft or repairing it in case of bending or breakage, and requirement of employing overhung flywheels unless an outboard or third bearing is kept in perfect alignment, or the alignment is compensated by a drag crank.

Overheating of Air Compressor

We have a 5½x5-in. stroke air compressor. The air cylinder becomes so hot as to cause the paint and oil on the outside to smoke. What is the reason for such overheating? *H. D.*

Heating of air-compressor cylinders would result from burning of the cylinder lubricating oil, especially if the cylinders are not water cooled, or from using cylinder lubricating oil that has too low a flash point, or having insufficient circulation of cooling water of low temperature, or from a combination of these causes. Excessive heating of compressor cylinders also may result from leakage of the discharge valves. The air becomes heated by compression, and when the discharge valves leak, the heated compressed air, in place of being discharged, is drawn back into the cylinder and is recompressed along with the free air taken in, and whenever that occurs there is the building up of a high temperature.

Piston Travel Clearance

How can the amount of piston travel clearance of an engine be found and equalized on each end of the stroke? *R. N.*

Clean off oil from one side of a crosshead shoe and the corresponding side of a guide and for making lead-pencil marks more distinct, rub chalk or a thin film of red or white lead on one side of the crosshead shoe opposite the crosshead pin and provide similar places on the guide for receiving pencil marks when the crosshead is at each end of the stroke. With a sharp lead pencil, make a mark on the crosshead shoe and a corresponding mark on the guide when the engine is on each dead center. Then disconnect one end of the connecting rod; slacken off the piston-rod packing and move the crosshead as far as it will go when the piston is pressed hard against first one end and then the other end of the cylinder, and each time make a mark on the guide to correspond with the mark previously made on the crosshead shoe. The distance between the marks made on the guide when the piston was in the same end of the cylinder indicates the amount of piston travel clearance in the corresponding end of the cylinder when there is the same length of connecting rod as the length that was used for locating the dead-center positions. If the clearances are not the same, they should be equalized by proper shimming of the connecting rod, so the distance from the outside or piston striking points to the mark on the crosshead shoe will be the same for both ends when the connecting rod is coupled and the crank is placed on dead centers.

The Pressure of Natural Draft Is Greater at Sea Level

Under the same constructional conditions, do boilers at a high elevation above sea level have better natural draft than those at a lower elevation? *T. J. H.*

Where there is the same form, height and size of chimney and the same temperature of external air and temperature of chimney gases, the chimney draft pressure, as measured by a draft gage, is greater at sea level than at a place of higher elevation where the barometric pressure of the atmosphere is less.

Chimney draft is caused by a difference of pressure at the base of the chimney, acting upward due to the difference between the weight of the heated gases in the chimney and a column of equal height and cross-section of the external air. In a given case, calling this difference of pressure p in pounds per square foot, where H is the height of the chimney in feet, D is the density of the external air, or weight in pounds per cubic foot, and D_1 is the density of the heated gases, pounds per cubic foot, gives

$$p = HD - HD_1 = H(D - D_1)$$

For the same temperature of the external air, the density is directly as the barometric pressure. The chimney gases are at the same pressure as the external air, and since for the same temperature their density varies as their absolute temperature, it follows that for the same temperature of external air and same temperature of the chimney gases in each case, the density of the chimney gas would bear the same ratio to the density of the external air. Therefore D_1 as also $D - D_1$, is the same fractional part of D, and $D - D_1$ varies directly as the value of D. But since D varies directly as the barometric pressure, it follows that $H(D - D_1)$, the value of the draft pressure, would be greater at the place of less elevation where the barometric pressure is greater.

Temperature and Work from Adiabatic Compression of Air

What are the formulas for calculating the final temperatures of adiabatic compression and expansion of air; and the formulas for calculating the amount of work done in either case? W. T.

The formula for calculating the final temperature of adiabatic compression or expansion of air is,

$$(T_d + 460) = (T_s + 460) \times \left(\frac{P_d}{P_s}\right)^{\frac{1.4-1}{1.4}}$$

where

T_d = Discharge temperature, deg. F.;
T_s = Suction temperature, deg. F.;
P_d = Absolute suction pressure, lb. per sq.in.;
P_s = Absolute discharge pressure = gage pressure + 14.7.

The formula for calculating the work done in adiabatic compression or expansion of dry air is

$$W = \frac{P_s \ V_s}{n-1}\left[1 - \left(\frac{P_d}{P_s}\right)^{\frac{1-n}{n}}\right] \times 144$$

W = Work in foot-pounds per cubic foot of free air;
n = 1.4;
V_s = Suction volume in cubic feet;
r = Final absolute pressure divided by initial absolute pressure $= \frac{P_d}{P_s}$

This is the work of compression or expansion only and does not include, in the case of compression, the work done in forcing the contents out of the cylinder, nor in case of expansion the work done upon the piston during the admission period. In either case this work $W_1 = 144\ P_d\ V_d$. The net total work is

$$W = 144\ \frac{n}{1-n}\left[1 - r^{\frac{1-n}{n}}\right] P_s\ V_s$$

Steam Accounted for by Indicator Diagram

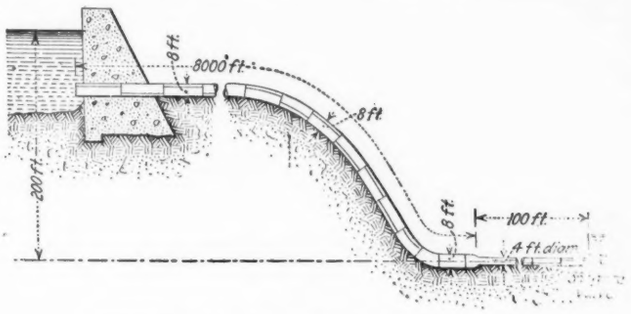
Why cannot steam accounted for by an indicator diagram be relied upon for determining the true steam consumption of an engine? R. K. C.

An indicator diagram shows the pressure at every point of the stroke. From that fact the valve action and the weight of dry steam present at cut-off may be inferred, provided the initial steam is not superheated, but the amount of steam admitted and condensed in compensation of cylinder condensation, or which is lost by leakage of the valves, cannot be accurately accounted for from the indicator diagram. Even with engines in good mechanical condition the steam unaccounted for is 10 to 45 per cent of the steam actually supplied to the engine, the percentage varying with the type of engine, the initial steam and the exhaust pressures, the load and other operating conditions. Used engines in time will develop leaks, and the shortage of the steam unaccounted for by the indicator diagram may be as much as 60 per cent of the actual steam consumption. One of the best uses that can be made of estimates of steam accounted for by an indicator diagram would be for finding the approximate amount of steam available from the exhaust for heating or other purposes. For steam heating the determination should be based on the weight of dry saturated steam represented by the volume and pressure present in the cylinder just before release, less the weight represented by the volume present after compression of the exhaust to the same pressure.

Water Discharged by Pipe Line with Gate Valve Wide Open

Having a lap-riveted steel water pipe line consisting of 8-ft. diameter pipe 8,000 ft. long and 4-ft. diameter pipe 100 ft. long with a 36-in. gate valve on the end, under a total head of 200 ft., as shown by the sketch, how is the velocity found (feet per second) which the water may be expected to have in passing through the valve when wide open and discharging against the pressure of the atmosphere? A. H. M.

The average velocity of water discharged would depend on the coefficient of discharge through the valve under the total head of 200 ft. less the loss of head at the entrance of the 8-ft. pipe and losses of head in the 8-ft. and 4-ft. sections of the pipe line when delivering the rate of flow discharged through the valve. The rate of discharge to satisfy these conditions can most easily be determined by assuming trial quantities and



Riveted pike line with 36 in. discharge valve

coefficient of discharge of the valve. The coefficient of velocity and discharge of the valve would be about 80 per cent of the theoretical quantity, and the head at the valve would have to be sufficient for creating the theoretical velocity, which would be 100 ÷ 0.80 = 1.25 times the actual velocity.

The head h in feet for a theoretical velocity v ft. per sec. is given by the formula,

$$h = \frac{v^2}{2g}$$

in which g = 32. The area of a 3-ft. diameter valve is 7.0686 sq.ft. Taking 500 cu.ft. per second as the actual discharge, the head required for the theoretical velocity would be

$$\left(\frac{500 \times 1.25}{7.0686}\right)^2 \div 2g \text{ or } \frac{(500 \times 0.17684)^2}{64.4} = 121.3 \text{ ft.}$$

leaving 200 — 121.3 = 78.7 ft. head for pipe friction. From interpolation of hydraulic tables giving the loss of head in riveted steel pipes, the discharge of 500 cu.ft. per second in the sizes and lengths of pipe given would cause a loss of about 60 ft. head or about 18 ft. head less than necessary for the discharge of 500 cu.ft. per sec. In the same manner, by assuming 550 cu.ft. per sec., it may be found that the total head required would be greater than the 200 ft. available, and by interpolating between 500 and 550 it may be found that the total head would be used up for discharge at the rate of about 515 cu.ft. per second.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

President Coolidge Appoints Federal Oil Conservation Board

Secretaries Weeks, Wilbur, Work and Hoover Named as Members—Present Wasteful Methods Deplored

THE PRESIDENT, on Dec. 19, issued a statement recognizing the responsibility of the government toward the whole subject of conservation by the creation of the Federal Oil Conservation Board. His announcement has additional significance in that it is plain recognition of the necessity for free and full, open and exhaustive cooperation between the government and business, and the need for joining forces to work out their common problem in practical conservation.

While the daily press of the country has carried the text of the President's announcement, its peculiar significance to engineers and industry justifies its reproduction in full herewith:

"It is evident that the present methods of capturing our oil deposits is wasteful to an alarming degree in that it becomes impossible to conserve oil in the ground under our present leasing and royalty practices if a neighboring owner or lessee desires to gain possession of his deposits.

"Developing aircrafts indicate that our national defense must be supplemented, if not dominated, by aviation. It is even probable that the supremacy of nations may be determined by the possession of available petroleum and its products.

"I am advised that our current oil supply is kept up only by drilling many thousands of new wells each year, and that the failure to bring in producing wells for a two-year period, would slow down the wheels of industry and bring about serious industrial depression. The problem of a future shortage in fuel and lubricating oil, not to mention gasoline, must be avoided, or our manufacturing productivity will be curtailed to an extent not easily calculated.

"We are not today, however, facing an under supply of oil. The production of our 300,000 wells is in excess of our immediate requirements. That overproduction in itself encourages cheapness, which in turn leads to wastefulness and disregard of essential values. Oil of which our resources are limited, is largely taking the place of coal, the supply of which seems to be unlimited, but coal cannot take the place of oil in most of its higher uses, on land or sea or in the air.

"For the purpose of giving this responsibility of government in all of its aspects the consideration it demands, I have constituted a Federal Oil Conservation Board consisting of the Secretaries of War, Navy, Interior and Commerce, to study the Government's responsibilities and to enlist the full cooperation of representatives of the oil industry in the investigation. The government itself is at present one of the largest lessors of oil lands, and the public domain still includes large undeveloped reserves of oil, so that the administration of oil resources is a practical question with the Department of the Interior.

"I would express the desire that these conferences may be open and exhaustive. The oil industry itself might be permitted to determine its own future. That future might be left to the simple working of the law of supply and demand but for the patent fact that the oil industry's welfare is so intimately linked with the industrial prosperity and safety of the whole people, that government and business can well join forces to work out this problem of practical conservation.

"Last March I appointed a commission to advise me on the special subject of the best policy to insure the future supply of fuel oil for the Navy. That commission will continue to function in its limited field and might to advantage sit with the Conservation Board in the conferences I expect will be held between these four Secretaries directly concerned, and the outstanding producers of petroleum. Similarly, the members of the Conservation Board will call upon their technical advisors in the bureaus to contribute to the full discussion of ways and means of safeguarding the national security through conservation of our oil."

The opening sentence of the President's announcement is regarded as indicating the fundamental trouble and the cause of waste present methods of "capturing" oil. It long has been recognized that "capture" is a word that quite conforms with the existing legal construction which, in practice, gives the most oil to the owner of the string of tools reaching the oil sand first, regardless of whether he owns a town lot or a 640-acre section. The first comer "captures" the oil as it flows past, according to one authority, much as the duck hunter shoots the birds on the fly.

Possessory rights in oil are recognized as being so uncertain under the present rules as to force haste. Regardless of the need for the oil, drilling once begun is pushed to the limit of financial and human endurance. It is very clear from the President's statement that he realizes that this is one of the best applications for the adage that haste makes waste.

It will be noted further that the President, while emphasizing the importance of oil in the national defense stresses its essentiality in peace-time industrial activities. In a few words he suggests that though fuel oil is replacing coal, coal cannot replace oil in its higher uses, and in the long run we have far more coal than oil.

Vienna To Be Supplied With Hydro Power

According to press reports, one of the largest water-power plants in Europe, located at Partenkirchen, Upper Austria, was opened recently and, within the next few months will begin generating electricity for all of Vienna and its immediate vicinity.

Lake Almanor Dam To Be Heightened

One of the first projects to be undertaken following the completion of the negotiations that are now reported to be under way for the acquisition of the San Joaquin Light & Power Corp. by the Great Western Power Co. will be increasing the height of the Big Meadows Dam on Lake Almanor in California by 45 ft. The enlargement of Lake Almanor will be followed by the installation of a fourth 22,000-kw. unit in the Caribou plant on the Feather River.

New Hydro Plant for Bear River, Utah

Having just completed the Soda development on the Bear River in Idaho, which added 14,000 kw. to its generating capacity, the Utah Power & Light Co., has completed plans for another hydro-electric development on the same river to be known as the Cutler plant. The proposed plant will contain two 15,000-kw. units operating under an effective head of 128 ft. A 110-ft. gravity and arch type concrete dam, creating a storage of 75,000 acre-feet, will be part of the development of the unappropriated waters of the Bear River in northern Utah.

The construction program in the building of this plant involves an expenditure of $5,500,000 and the employment of approximately a thousand men for two years. A third 130-kv. transmission line 80 miles in length will be built from the new plant to Salt Lake City, the load center of the Utah Power & Light system. It is expected that actual construction work will be under way by March 1, 1925.

Metropolitan Engineers Study Furnace Design

Radiant Type of Superheaters Recommended—Water Tubes as a Substitute for Refractories—Stationary Boilers Cannot Equal Locomotive Performance

AT A MEETING of the Metropolitan Section of the American Society of Mechanical Engineers, Dec. 19, George Van Tuyl, of the Power Specialty Co., read a paper on "Reducing Costs of Steam Generation."

Until one or two years ago most boilers were designed with little attention given to the extraction of radiant heat from the furnace, or the recovering of waste heat from the flue gases leaving the boiler. The best possible performance that could be expected was to reduce the temperature of gases leaving boilers to about 450 deg. F. at low ratings and with steam pressures of 200 lb. or less.

These designs are now being improved upon, and the speaker discussed methods of absorbing additional radiant heat from the furnace and the recovery, by means of economizers, of waste heat in the gases leaving the boilers.

The maximum possible extraction of heat by radiation from the furnace is not new and has been done for many years in the Scotch-marine, locomotive, Cornish and other types of fire-tube boilers. In the case of water-tube boilers, however, a great many have argued—but without actual experience to back such arguments—that the heating surface exposed to direct radiation from the furnace should be held down to a minimum. It was reasoned that a hot furnace is desirable because combustion proceeds more and more rapidly as the temperature of the reacting constitutents increases. This is correct, but when the temperatures found in boiler furnaces are reached, the reaction may be considered instantaneous. The real reason for the delay in combustion in a furnace is the difficulty of mixing the combustible gases and solids with free oxygen.

Additional heating surface in the furnace takes the place of less durable brickwork, reduces the temperature of the furnace and reduces the temperature of gases leaving the boiler. All these effects are beneficial. Reducing the amount of brickwork and the temperature of the furnace makes it practicable to operate at higher ratings and reduces the cost of maintaining the furnace. It also permits higher CO_2, and this decreases the temperature and amount of gas leaving the boiler and increases the thermal efficiency. Assuming that the Stefan-Boltzmann Law for black body radiation holds for a furnace, it may be shown that, if gases leave the furnace at 2,400 deg. with no water-cooled walls installed, the installation of water walls of the same area as the projected area of the tubes facing the furnace will reduce the furnace temperature to about 2,200 deg.

The furnace may be cooled by steam instead of water. In other words a radiant-heat superheater may be used. In a great many plants probable future practice will be to use a radiant superheater on the rear wall, and water-cooled walls on the two sides, and possibly the front of the furnace.

The performance of radiant-heat superheaters has been checked from actual tests, and one of its merits, apart from those attributed in general to any heat-absorbing surface in the furnace, is the shape of the curve showing variation of superheat with rating. With convection superheaters, generally, superheat increases with rating and decreases as the CO_2 increases. With radiant-heat superheaters, the superheat, up to a certain point, increases with the rating but beyond that, decreases with the rating and increases with an increase of CO_2.

When radiant-heat superheaters are used alone, the characteristic reduction of superheat as the CO_2 decreases, is an advantage from an operating viewpoint, in that, if because of poor combustion conditions the CO_2 falls off, there is no danger of a sudden rise of superheat that might give trouble in the piping, valves, engines or turbines.

There is a marked tendency to install water-cooled surface or water-backs in the rear wall of the setting at the foot of underfeed stokers. In such installations the surface extends, as a rule, for only a short distance from a point below the fire line to a point above the top of the clinkers which ordinarily accumulate on the stoker dump plates. A certain amount of work is done in such water backs, but the principal object of making installations like this is not so much the general effect of furnace conditions as it is to reduce clinker troubles by substituting for a brick wall, to which clinkers adhere and fuse, a water-cooled wall which gives no trouble of this kind.

In one plant where the boilers were equipped with radiant superheaters in the pulverized-coal furnace, it is of interest to note that, when the load increased from 140 to 270 per cent, the CO_2 increased from 11.9 to 15.5 per cent, but there was a variation in superheat of only 5 deg. In this plant the practice is to operate the soot blowers only as required to maintain practically constant superheat at all ratings.

The discussion of the paper turned to the problem of the proper location of the superheater. One builder of this apparatus strongly recommended that the elements be placed between the water-cooling pipes in order to limit the heat absorption of the elements. If the superheater tubes were exposed, the steam temperature would vary widely with load changes.

The several furnace designs used at Hell Gate were shown by lantern slides. It was stated that no trouble has been experienced with the water tubes and that the erosion of the brick linings had been reduced to a marked extent.

The high rate of evaporation per square foot of grate surface of locomotive boilers was commented upon, and in view of the small water-cooled furnaces used, the question was asked as to why similar results were impossible in a stationary boiler furnace.

Senate Adjourns Without Action on Muscle Shoals

The Senate adjourned Dec. 20 for the holiday recess without having disposed of the Muscle Shoals matter. As none of the votes had thus far on amendments to the Underwood bill furnished an indication of how the members would vote on a decisive question, it is becoming increasingly apparent that the proposal to refer the entire matter to a commission will be the legislation which finally will be written on the statute books.

As Congress adjourned, public ownership versus private ownership was being argued. As this question presents wide opportunities for discussion, there is no predicting when the debate will be concluded, but it would not be surprising were definite action taken by the Senate shortly after reconvening in January. The decisive vote doubtless will come on the Jones amendment, which provides that the matter be referred to a commission instructed to report in December, 1925.

Massachusetts Coal Again Under Investigation

Recommendation has been made, by the Massachusetts Commission on the Necessaries of Life, to the incoming legislature that it appropriate $50,000 for borings and field tests to ascertain whether the coal from the so-called Narragansett coal basin, which covers 100 square miles in Bristol, Plymouth and Norfolk counties, can be mined profitably. These coal deposits have been known for over a century, and the coal for many years was mined and used for smelting copper.

Preliminary investigations have been made by a Commission appointed under the last legislature, which has had expert help. Three of the four experts are of the opinion that the deposits may have commercial value. The Commission reports that, "while many of the attempts made to develop these coal deposits were simply stock promotion schemes, others failed because this coal could not compete with high-grade Pennsylvania coal as a domestic fuel. Reports examined by the Commission indicate that the Rhode Island coal, which belongs to the same coal area, is of a hard structure, graphitic in nature and slow to kindle. It is brittle and difficult to prepare for the market in sizes. It contains a higher percentage of ash and moisture than Pennsylvania coal." The Chairman of the Commission, Eugene C. Hultman, believes that any coal produced in Massachusetts would have a certain economic value because the tremendous costs of transportation would be eliminated. He holds out no hope that the coal would be satisfactory for household uses, but does believe that it could be used near its source for the production of electric power, and thus relieve the manufacturing industries of that section of one of the largest items of overhead expense. One of the large power stations has been trying it out in pulverized form.

New York State Discontinues Suit Against United States

The Attorney-General of New York State, Carl Sherman, announced on Dec. 19 that New York State had discontinued its suit against the United States. This suit was instituted during the administration of Attorney-General Newton, for the purpose of testing the powers of the Federal Water Power Commission under the Esch Water Power Law.

Valmont Steam Plant Placed in Operation

The first unit of 20,000 kw. in the new Valmont steam plant of the Public Service Co. of Colorado, was placed in operation Nov. 30, and the installation of four additional units of the same size will follow as demand necessities. The plant is about three miles from Boulder, Colo. Pulverized coal is the fuel used. A 110-ft. dam on South Boulder Creek creates a storage reservoir of over 9,000 acre-feet capacity for condenser cooling water. A 24-mile 110-kv. transmission line connects the plant with the Lacombe station in Denver, one of the main distribution points of the company's system. The cost of the work just completed was approximately $5,000,000.

President Asks Aid for St. Lawrence Survey

President Coolidge has urged Congress to make $275,000 available for completing surveys to determine the feasibility of the proposed Great Lakes-St. Lawrence waterway, according to press reports. The money sought should prove sufficient to complete the preparations of plans and estimates by the United States section of the Government Board of Engineers on the St. Lawrence project.

The President says: "The Canadian government has already spent $247,931.26 in investigating this subject and has appropriated $150,000 more for expenditure in the present fiscal year.

"There is still much definite information to be obtained to determine the best plan of development and a reliable estimate of its cost. The United States should bear its fair share to bring the investigation to a conclusion."

Colorado River Bill Hearing Continued

Interest in the solution of the Colorado River problem and its effect on the cities and agricultural lands of the Southwest is being manifest during the hearings on the Swing-Johnson bill before the Senate Committee on Irrigation and Reclamation, according to press reports.

Representatives of Imperial Valley, Los Angeles and other communities lined up in support of the project for a dam at Boulder Canyon are being heard by the committee, which has announced its determination to speed up action on the measure. It is expected to be reported soon from the House Irrigation Committee. Eight volumes of testimony taken by the House Committee have been placed before the Senate for information on the subject.

A new angle on the subject was presented at the hearings on Dec. 22, when W. J. Carr, of Pasadena, vice-president and director of the Boulder Dam Association, outlined to the committee a suggested amendment to the bill, intended to meet objections of the upper stream states by safeguarding their water rights against any possible encroachments by reason of water rights established by the Boulder Dam Reservoir. This amendment, he asserted, would serve the same purposes as the Colorado River Compact, now held up by the refusal of Arizona to ratify the contract. This would be accomplished by writing into the bill provisions binding both the government and the lessees of power sites to guarantee the water rights of the upper states, according to the terms of the compact. There is nothing new in this form of guarantee, he declared, the Federal Power Commission having frequently written such clauses into its grants on power sites.

Engineer Observer Describes Rotor Ship Trials

The brief newspaper accounts of the public demonstration of Herr Flettner's rotor ship "Buckau" on Dec. 3 are amplified by a correspondent of *The Engineer* (London). Writing in the Dec. 12 issue of *The Engineer*, he said, in part: "On Wednesday, Dec. 3, a public demonstration of the 'Buckau' was made in Kiel Bay. The wind was very light and there was no sea. Maneuvers could be seen only through glasses between the heads of several hundred more or less interested spectators on board a crowded steamer. The steamer lay stationary, while the rotor ship described an oblong about her. It was more a 'hurrah party' than a scientific demonstration."

"Using the Flettner cylinders alone, the 'Buckau' started with the wind to beam and the towers rotating at some 120 r.p.m. She passed some four hundred yards away at about four knots, which is approximately the speed she would have attained with her original three-masted topsail schooner rig."

After describing the various maneuvers, he continued as follows: "On returning to the quay, I went on board with the crowd and saw the one man control on the bridge. It consisted merely of two wheels, like steam valve wheels, on which are arrows working over horizontal scales marked from zero to 120 revolutions in either direction. The wheel marked 'fore tower' was set at 40 revolutions in one direction, and accordingly that tower was rotating at forty revolutions. I would say a novice would soon learn to maneuver the ship, once told that all his forces are at right angles to the wind, and to revolve the tower so that the side of it which lies toward the direction in which he wants it to go moves with the wind."

"Arriving at the fore tower and putting my hand close to its surface, I only felt a very small draft. The towers are quite smooth, with a newly painted surface."

"The rotating part of each tower weighs one ton and each tower has a hub or diaphragm one-third way down inside, revolving on forced lubrication bearings (not ball bearings) one horizontal to take the ton weight, and one vertical to take the heavier side propelling thrust. These bearings are set on top of a strong hollow steel mast stepped on the keel. Thus both the weight and propelling thrust come on top of the fixed mast, though there is also a bearing round the lower edge of the tower near deck level. He (Flettner) intends to lecture in England during February and to bring the rotor ship to England. Herr Flettner has been waiting a month for a gale in the Baltic." [In order to test out his claim that a gale would not put extra strain on the towers—EDITOR].

"Three towers could be fitted, especially as there being no stays the mast can be stepped farther forward and aft than in a sailing ship. My own personal opinion, for what it is worth, is that wherever sails are used these towers would probably be better. In fact they are good for auxiliary ships. The inventor himself does not claim more for them."

Program of Cleveland Meeting on Pulverized Fuel

The Cleveland Engineers Society in co-operation with the Cleveland sections of the A.S.M.E. and A.S.H. & V.E. will hold an all-day meeting on "Steam Production Economies" on Jan. 13 at the Hotel Winton. The morning session will be devoted to a paper by Walter Kline, of the American District Steam Co., of North Tonawanda, N. Y., on "Group-Plan Heating for Apartment and Residential Districts." In the afternoon and evening there will be a symposium on "Pulverized Fuel" with the following papers:

AFTERNOON SESSION, 2 P.M.

"History of the Development of Pulverized Coal as a Boiler Fuel," by W. H. Brooks, Bureau of Mines, Pittsburgh; "The Central Pulverizing Plant and Its Operation," by Henry Kreisinger, Combustion Engineering Corp., New York City, and H. G. Barnhurst, Fuller-Lehigh Co., Fullerton, Pa.; "The Unit Pulverizing Plant and Its Operation," by W. H. Pettibone, Aero Pulverizer Co., New York City, W. E. Irish, Erie City Iron Works, Erie, Pa. and Gould Coutant, Furnace Engineering Co., New York City.

EVENING SESSION, 8 P.M.

"Burning Pulverized Fuel in Large Boilers with Results Obtained in Recent Tests," by John Wolff, Cleveland Electric Illuminating Co., Cleveland; "Some Design Features and Operating Experiences in Connection with the Detroit Edison Trenton Channel Plant," by D. W. Thompson, Detroit-Edison Co., Detroit; "Some Features of Design and Operating Experiences in the Utilization of Low-Grade Fuel at Cahokia Station of the Union Electric Light & Power Co., St. Louis; "The Results to Date after Four Years of Developing Pulverized Fuel at Lakeside," by John Anderson, Milwaukee Electric Light & Railway Co., Milwaukee.

Society Affairs

The A.S.M.E. local committee for the Spring meeting, which is to be held in Milwaukee, May 18-21, will consist of Fred H. Dorner, chairman, Robert Cramer, secretary, W. C. Lindemann, Arthur Simon, A. C. Flory, C. A. Cahill, John D. Maurer, Will J. Sando and E. F. Johns. This executive committee will be in charge of all the arrangements and preparations for the meeting in Milwaukee.

Personal Mention

Fred J. Lindauer is now in the hydraulic department of the Fairbanks, Morse & Co., Three Rivers, Mich., as experimental engineer.

Frank A. Merrick, now vice-president and general manager of the Canadian Westinghouse Co., has been elected vice-president and general manager of the Westinghouse Electric & Manufacturing Co., with offices at East Pittsburgh, Pa., effective Jan. 1.

Business Notes

The Louis Allis Co., manufacturer of electric motors, has removed its New York City Office from 345 Madison Ave., to 8 East 41st St., room 801.

Gifford-Wood Co., Hudson, N. Y., manufacturer of coal- and ash-handling equipment, announces that Byron B. Phillips severed his connection with that organization on Dec. 15.

Ballard Sprague & Co., Inc., 200 Fifth Ave., New York City, constructors of chimneys and boiler settings, announces the opening of a new office at 1308 Swetland Bldg., Cleveland, Ohio., with H. C. Maslen in charge.

The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., announces that after Jan. 1, the office of president of the company, E. M. Herr, will be moved to the Westinghouse Bldg., 150 Broadway, New York City.

The Marion Machine, Foundry & Supply Co., Marion, Ind., announces that Alfred E. Bilander, formerly with the Tide-Water Oil Co., is its representative for New Jersey. He is connected with the New York office at 116 West 39th St. and will specialize in soot blowers and hand stokers.

The Riley Stoker Corp., 9 Neponset St., Worcester, Mass., is the new name for the Sanford Riley Stoker Co. and its subsidiaries which becomes effective on Jan. 1, 1925. The change is wholly for convenience in the transaction of business and is not a change in management or policies. The company is a consolidation of the Sanford Riley Stoker Co., maker of Riley underfeed stokers, the Murphy Iron Works, Detroit, Mich., maker of Murphy furnaces, the Underfeed Stoker Company of America, maker of Jones stokers, and the United Machine & Manufacturing Co., Canton, Ohio, maker of Harrington stokers.

Coming Conventions

American Boiler Manufacturers Association. H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Midwinter meeting at Cleveland on Feb. 12.

American Ceramic Society. R. C. Purdy, Lord Hall, Ohio State University, Columbus, Ohio. Convention at Columbus, Ohio, Feb. 16-21.

American Engineering Council. L. W. Wallace, 24 Jackson Place, Washington, D. C. Annual meeting at Washington, D. C., Jan. 16-17.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at New York City, Feb. 9-13.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 16-19.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, N. J., June 22-26.

American Society of Heating and Ventilating Engineers. F. C. Houghten, 33 West 29th St., New York City. Annual meeting at Boston, Jan. 28-30.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Milwaukee, Wis., May 18-21.

Canadian Association of Stationary Engineers. Geo. J. Soucy, 48 Moore Ave., Toronto, Ont., Secy. Convention at Windsor, R. M. McLaren, 160 Doorcourt Rd., Toronto, Ont., June 29-July 1.

Engineering Institute of Canada. Fraser S. Keith, 176 Mansfield St., Montreal, Que. Annual meeting at Montreal, Que., Jan. 27-29.

Exposition of Inventions—American Institute, E. W. Bartlett, 47 West 34th St., New York City. Exposition at Engineering Societies Bldg., 29 West 39th New York City, April 27 to May 2, formerly announced for Dec. 8-13.

Illinois Society of Engineers. E. R. Tratman, Wheaton, Ill. Meeting at Chicago, Jan. 14-16.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Des Moines, Iowa, Jan. 27-30.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Pennsylvania Association** at Pittsburgh, Pa., May 15-16. Frank J. McCarron, 3647 North 11th St., Philadelphia, Pa. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **New England States Association** at Worcester, Mass., June 18-20. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

National Marine Engineers Beneficial Association; Geo. A. Grubb, 313 Machinists Building, Washington, D. C. Convention at Hotel Franklin Sq., Washington, D. C., Jan. 19.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, National convention at Hotel Winton, Cleveland, Ohio, May 6-8.

Western Association of Electrical Inspectors. G. M. Miller, 1304 South 7th St., Louisville, Ky. Annual convention at the Brown Hotel, Louisville, Ky., Jan. 27-28.

Trade Catalogs

Turbines, Steam — De Laval Steam Turbine Co., Trenton, N. J. Catalog "C" describes this company's velocity-stage steam turbines. It is well illustrated with photos and cross-sections.

Electrical CO_2 Measuring Instrument—The Brown Instrument Co., Philadelphia, Pa. Catalog No. 32 gives a complete description of this instrument for indicating and recording CO_2 electrically.

Cranes, Electric Equipment for—General Electric Co., Schenectady, N. Y. Bulletin No. 48732 covers the electric equipment for cranes using either alternating or direct current motors. The bulletin is well illustrated and contains tables of ratings for motors and other useful information.

Sprocket Wheels and Chain Belting—W. A. Jones Foundry & Machine Co., 51 West Roosevelt Road, Chicago, Ill. Catalog No. 32 describes the sprocket wheels and detachable chain manufactured by this company. Convenient tables and illustrations of the parts are included as well as price lists.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal, Net Tons	Market Quoting	Dec. 15, 1924	Dec. 22, 1924
Pool 1	New York	$2.95	$2.95
Smokeless	Columbus	2.25	2.10
Clearfield	Boston	2.25	2.40
Somerset	Boston	2.40	2.50
Kanawha	Columbus	1.65	1.65
Hocking	Columbus	1.75	1.75
Pittsburgh No. 8	Cleveland	1.90	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville	1.75	1.75
S. E. Ky.	Louisville	1.50	1.50
Big Seam	Birmingham	1.75	1.90

FUEL OIL

New York—Dec. 24, light oil, tank-car lots; 28@34 deg. Baumé, 5c. per gal.; 36@40 deg., 5¼c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Dec. 16, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.95 per bbl.; 26@28 deg., $2.00 per bbl.; 28@30 deg., $2.05 per bbl.; 30@32 deg., $2.10 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Dec. 16, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.

Dallas—Dec. 16, f.o.b. local refinery, 26@30 deg., $1.20 per bbl.

Philadelphia—Dec. 18, 28@30 deg., $2.20½@$2.268 per bbl.; 18@20 deg., $2.047@$2.11; 13@16 deg., $1.89@$1.953 per bbl.

Boston—Dec. 22, tank-car lots, f.o.b.; heavy oil, 12@14 deg., Baumé, 4½c. per gal.; light oil, 28@32 deg. Baumé, 5½c. per gal.

Cincinnati — Dec. 16, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¾c. per gal.; 26@30 deg., 5¾c. per gal.; 30@32 deg., 6¼c. per gal.

Chicago—Dec. 16, tank-car loads, delivered within city limits, 20@22 deg., 6c. per gal.; 24@26 deg., 6c.; 28@30 deg., 6¼c.; 30@32 deg., 6¾c. per gal.

New Plant Construction

Ariz., Tombstone—The City plans an election on Jan. 13 to vote $25,000 bonds for the installation of a municipal light, power and ice plant. Engineer not selected.

Calif., Alhambra—Hamm & Grant, Inc., Industrial Engrs., 607 Ferguson Bldg., Los Angeles, have completed plans for the construction of a 30-ton ice manufacturing plant at Lemon and Palm Sts., for the Pasadena Ice Co., estimated cost $15,000.

Calif., Brawley—The City, O. M. Juvenal, Clk., plans to purchase 1 generator, 150 kva., and 2 generators 75 kva. to connect with diesel engine.

Calif., Los Angeles—F. A. Elliott, c/o Jonathan Club, Pacific Electric Bldg., awarded the contract for the construction of a 12 story hotel and store building on West 6th St., to Orndorff Construction Co., 351 North Western Ave., estimated cost $526,500. Complete refrigeration, steam heating and ventilating systems, 1 freight and 2 passenger elevators will be installed.

Calif., Los Angeles—S. Goodman, c/o Meyer & Holler, 315 Wright-Callendar Bldg., contractors, awarded the contract for the construction of a 13 story, 50 x 90 ft. store and loft building on 7th St.

Calif., Los Angeles—Harris & Frank, 443 South Spring St., are having plans prepared for the construction of a 12 story, 60x150 ft. store and loft building on Hill St. Curlett & Beelman, Union Bank Bldg., are architects.

Calif., Los Angeles—E. E. Morgan, 580 North Vine St., awarded the contract for the construction of a 13 story office building at 8th and Francisco Sts., to Simpson Construction Co., Bank of Italy Bldg.

Calif., Los Angeles—Seventh-Main Bldg. Co., c/o Curlett & Beelman, Union Bank Bldg., Archts., awarded the contract for the construction of a 12 story, 145 x 170 ft. office and loft building at 7th and Main Sts., to Baker Iron Works, 912 North Broadway.

Calif., Santa Monica—J. Armstrong, 38 South Dearborn St., Chicago, Ill., Archt. is preparing plans for the construction of a 11 story, 100 x 150 ft., hotel at Ocean and California Aves., for A. I. Jordan, 111 West Washington St., Chicago.

Calif., Santa Monica—Shoreham Hotel Co., 124 San Vincente Blvd., awarded the contract for the construction of an 11 story apartment and hotel on Ocean Ave., to Trewhitt-Shields, Western Mutual Life Bldg., Los Angeles, estimated cost $1,000,000.

Calif., Venice—Santa Monica Dairy Co., 346 Rose Ave., will build by day labor an addition to their plant, including a boiler room, 21 x 25 ft. with two 75 hp. boilers, unloading platform with conveyor system, etc., estimated cost $30,000. Hamm & Grant, Inc., Industrial Engrs., 607 Ferguson Bldg., Los Angeles, are engineers.

Calif., Wilmington — Latin-American Fruit & Steamship Corp., 1215 Hibernian Bldg., Los Angeles, has had preliminary plans prepared for the construction of a warehouse, pre-cooling and cold storage plant, estimated cost to exceed $150,000. M. Kane, 1215 Hibernian Bldg., is engineer.

D. C., Washington—A. L. Flint, Gen. Purch. Officer of the Panama Canal, will receive bids until Jan. 9 for boilers, pumps, transformers, etc.

Ga., Atlanta—Georgia State Baptist Convention, M. H. Massey, Chr., Americus, authorized $500,000 bond issue for the construction of a hospital here.

Ill., Chicago—L. A. Bensinger & Son, 73 West Monroe St., is having plans prepared for the construction of a 5 story office and sports building at Wabash and Congress Sts., estimated cost $600,000. A. Alschuler, 28 East Jackson Blvd., is architect.

Ill., Chicago—Broadview Hotel Co., c/o contractors, awarded the contract for the construction of a 7 story hotel at 5532-48 Hyde Park Blvd., to C. B. Johnson & Son, 111 West Washington St., estimated cost $1,200,000.

Ill., Chicago—Graham, Anderson, Probst & White, 80 East Jackson Blvd., Archts. and Engrs., are making sketches for a group of buildings, including a convention hall, hotel with 3500 rooms, railroad terminal station, etc., on Michigan Ave. and River St., for group of business men, F. O. Lowden, Chr., estimated cost $30,000,000.

Ill., Chicago — Randolph Hotel, Eitel Bros., 177 West Randolph St., awarded the contract for the construction of an 18 story hotel on Randolph St. between LaSalle & Wells St., to Hegeman-Harris Co., Inc., 360 Madison Ave., New York City, estimated cost $6,000,000.

Ill., Chicago—Stevens Hotel Co., c/o Holabird & Roche, 104 South Michigan Ave., archts. and engrs., will soon receive bids for the construction of a 25 story hotel on Michigan Ave., between 7th and 8th Sts., estimated cost $20,000,000.

Ind., Indianapolis—L. Strauss & Co., 33 West Washington St., plans the construction of a 11 story office building on North Illinois St. Rubush & Hunter, American Central Life Bldg., are architects.

Md., Baltimore—E. L. Palmer, 513 North Charles St., Archt., awarded the contract for the construction of a 5 story apartment house, including heating and ventilating system, at Upland and Club Rds., for the Roland Park Apartments Co., to M. A. Long Co., 17 Guilford Ave., estimated cost $900,000.

Mich., Detroit—Palms Realty Co., 1715 Ford Bldg., awarded the contract for the construction of a 12 story theatre and office building on Woodward Ave., including steam heating equipment, etc., to Longacre Engineering & Construction Co., 345 Madison Ave., New York City, estimated cost $2,000,000.

Mich., Detroit—Weston & Ellington, Stroh Bldg., Archt., representing owner, is preparing plans for the construction of an 11 story apartment and store building, including steam heating plant, estimated cost $800,000.

Minn., Minneapolis—The City, F. S. Gram, Purch. Agt., extended date of bids to Jan. 9 for the construction of a garbage incinerator, bidders to present own plans to cover structure proper, furnishing and installing equipment including boilers, cranes, hoists, air compressors, etc., capacity 200 tons daily, estimated cost $225,000. N. W. Elsberg is city engineer.

Mo., Kansas City—Quality Builders Inc., 1517 Commerce Bldg., is having plans prepared for the construction of an 8 story hotel, estimated cost $1,200,000. Mrs. N. E. Peters, c/o owners, is architect.

N. J., Atlantic City—N. J. Collins, c/o W. M. Stanton, 1524 Chestnut St., Philadelphia, Pa., Archt., is having preliminary plans prepared for the construction of a hotel on Pennsylvania Ave., near Boardwalk, containing 300 rooms.

N. J., Atlantic City—Maynicke & Franke, 25 East 26th St., New York City, will receive bids until Jan. 10 for the construction of a 20 story hotel at Boston and Providence Aves. and Boardwalk, for the Benjamin Franklin Hotel Co., estimated cost $10,000,000.

N. J., Passaic—Eagle Iron & Brass Foundry is in the market for one 40 hp. and one 60 hp., 220 v., 60 cycle motors.

N. Y., New York—Gilman-Schlesinger Bldg. Co., c/o G. G. Miller, 1482 Broadway, Archt. and Engr., is having plans prepared for the construction of a 9 story office building on Arthur Ave. near Tremont St., estimated cost $550,000.

N. Y., New York—F. T. Ley & Co., 19 West 44th St., will build a 22 story office building at 80 John St. Shreve & Lamb, 52 Vanderbilt Ave., are architects.

N. D., Valley City—The City, O. N. Bergman, Supt. Municipal Electric Light & Water Works, will receive bids until Jan. 5 for one 1,000 kw. 80 per cent P. F. turbo alternator, with surf condenser, auxiliary equipment, piping, connections and coal handling equipment.

O., Cleveland—The Ajax Mfg. Co., H. D. Hemen, Mgr., 3830 Lakeside Ave., manufacturers of bolt and nut machinery, awarded the contract for the construction of a plant at Chardon Rd. and Nickel Plate Railroad, including a boiler house, to H. K. Ferguson Co., 4900 Euclid Ave., estimated cost $300,000.

O., Cleveland—The City has had plans prepared for the construction of a sewage disposal plant, screen buildings, pump house, etc., at Willow Station, estimated cost $3,500,000.

O., Dayton—United Real Estate Development Co., M. L. Simon, Pres., 1528 North Euclid Ave., plans the construction of an 8 to 10 story, 68 x 72 ft. office building on West 2nd St., estimated cost $800,000.

O., Warren—Union Savings & Trust Co., R. A. Cobb, has had plans prepared for the construction of a 9 story bank and office building, estimated cost $500,000. Keith, O'Brien & Hosker, are architects.

Pa., Pittsburgh — Smithfield & 6th Ave. Land Co., has awarded a general contract for the construction of a 4 and 6 story office and store building, to Mellon Stuart Co., Oliver Bldg., estimated cost $500,000.

Tenn., Memphis—Coca Cola Bottling Co., Washington Ave. and North 4th St., plans additional buildings including ice machines, pumping wells, etc.

Tex., Ballinger—West Texas Utilities Co., E. Morley, Dist. Mgr., plans the construction of a 40-ton ice plant, including electrically driven, machinery, estimated cost $70,000. Private plans.

Tex., Dallas—Dallas Power & Light Co., J. H. Gill, Asst. Gen. Mgr., 216 Interurban Bldg., will build by day labor a power plant, including a 25,000 kw. turbo generator unit, 17,000 sq. ft. boiler capacity, condenser, pumps, switchboard, etc., estimated cost $2,500,000. Private plans.

Tex., Galveston—G. K. Jorgenson & Co., Palace Bath House, Galveston Beach, are having plans prepared for the construction of an 11 story hotel at 23rd St. and Boulevard, estimated cost $1,500,000. W. S. Murdock, 506 American National Insurance Bldg., is architect.

Tex., McAllen — H. P. Smith, National Bank of Commerce, San Antonio, Archt., will receive bids until Jan. 10 for the construction of a college, including administration building, 2 dormitories and a power house, to be known as Carroll College for the Baptist Church, estimated cost $250,000.

Tex., San Antonio—Mission Ice Co., 212 Rivas St., is having plans prepared for the construction of an ice plant, including machinery, at Blanco and Fredericksburg Rds., estimated cost $40,000 L. Harrington & Co., Houston Bldg., are engineers.

Tex., Victoria—R. E. Hill & Co., c/o R. E. Hill Grain Co., will build by day labor an ice and cold storage plant on Main St., estimated cost $42,000.

Wash., Tacoma—The Commissioners of Light and Water will soon award the contract for the construction of a 3 story substation at North 21st and Adams Sts., for the Lake Cushman hydro-electric project, estimated cost $150,000.

Wash., Wickersham—Wickersham Light & Power Co. have obtained a permit to use one cu. ft. per second of water from Ennis Creek for light and power purposes. The construction of a dam and power line is contemplated.

Wis., Lancaster—The City, F. B. Barnett, Clk., plans to install 100 hp. engine for water supply.

Wis., Milwaukee—M. Tullgren & Sons, 425 East Water St., archts. and engrs., are preparing preliminary plans for the construction of an 8 story warehouse and cold storage plant on West Water St., including refrigeration machinery, estimated cost $1,500,000. Owner's name withheld.

N. S., Halifax—Beaudry & Patterson are in the market for crude oil engine, 30 hp. complete with clutch.

Volume 60 December 30, 1924 Number 27

POWER

FRED R. LOW, *Editor* A. D. BLAKE, *Associate Editor*

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1925

will bring greater prosperity

May you receive
your full share

POWER

KEYSTONE ACCOMPLISHMENTS

No. 1 of a series

"We are pleased to say that the Keystone Lubricating Greases that we have been using, especially No. 1 and 6 density, have proven very satisfactory to every test that we have put them.

"In our former experience of six years of using the ordinary greases and our experience in the past four years with the Keystone greases we have positively experienced that we are greatly benefited in every way as to waste, cleanliness and service and wear produced. One pound of Keystone Grease will go as far as three pounds of any common ordinary grease. With the care that we are taking of it we are today using one pound of grease, whereas it would take four pounds of ordinary grease.

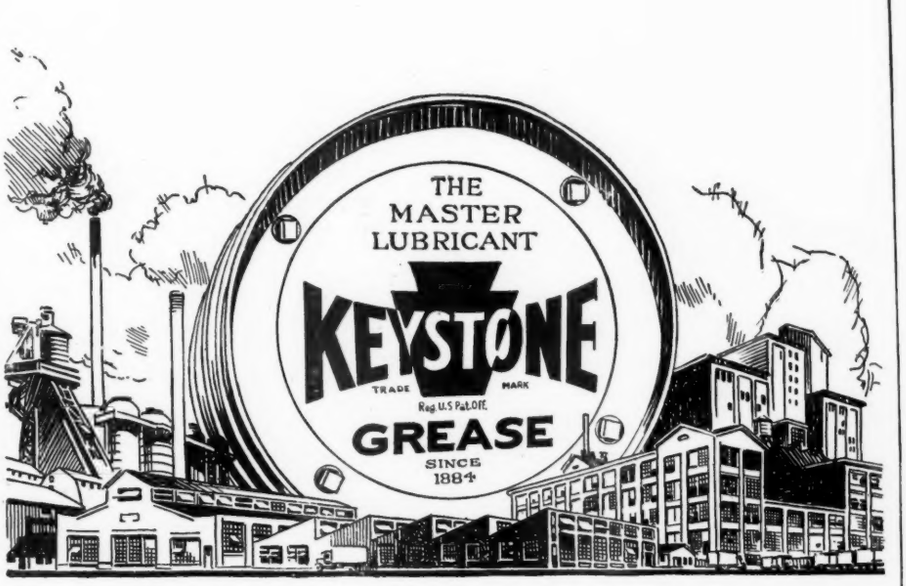
"No one needs to fear the results of these greases, as they are reliable, substantial, uniform and well-proportioned greases."

Taken from a nationally known manufacturer's letter to Keystone.

Buying executives facing cost-reduction problems will find an exchange of ideas with a Keystone Sales Engineer profitable. Through our sales engineers, Keystone's forty years' experience in cutting lubrication costs is available.

To insure your seeing the Keystone representative when he calls, we would suggest that the executive responsible for specifying the lubricant to be used write us expressing his desire.

KEYSTONE GREASE



The Guardian of Countless Bearings

AFTER all, there is only one place where a lubricant is worth anything to you, and that is in your bearings. If it is Keystone Grease, it will stay in its proper place and lubricate, because of its unchanging density.

Keystone Grease is a pure petroleum product made in densities to suit various conditions. It is as honest a lubricant as can be made and safeguards countless thousands of bearings in America's leading industrial plants. THE KEYSTONE LUBRICATING CO., *Est. 1884*, PHILADELPHIA, PA., *at 21st & Clearfield Streets.*

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The Master Lubricant

For Every Industry

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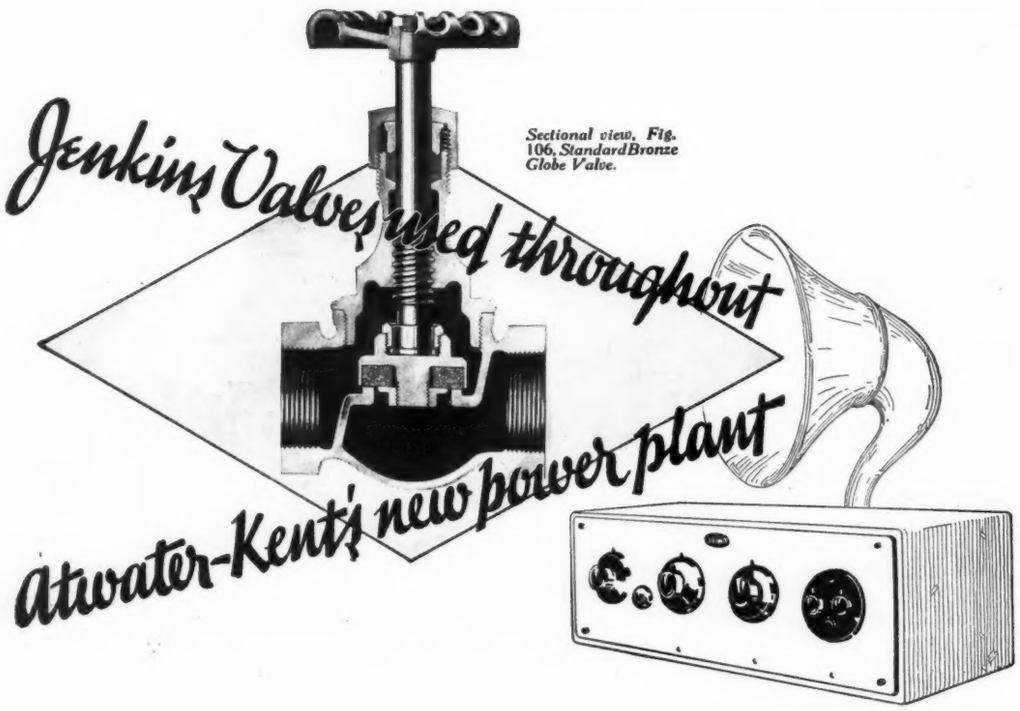

Sectional view, Fig. 106, Standard Bronze Globe Valve.

EVERY RADIO FAN knows the Atwater-Kent receiving set — hundreds are being sold every day. The wheels of production must be kept turning to answer this great popular demand.

Machinery and equipment in the New Atwater-Kent plant at Philadelphia was selected on the basis of service. It had to be of proven performance.

And in providing means to keep production at top notch, Jenkins Valves were the logical choice.

The engineer, on whom plant efficiency depends, usually selects Jenkins Valves and installs them wherever he can. They are made for the maximum service, not merely for the average, and are guaranteed in the service for which they are recommended.

Valves for all requirements — at supply houses everywhere.

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Always marked with the "Diamond"

Jenkins Valves

SINCE 1864

A Cleaner in the hand is worth tubes in the boiler

The use of a Tube Cleaner is always profitable. Without cleaning, scale accumulates rapidly in the tubes, and a scaled tube is both wasteful and dangerous. When many tubes are covered with scale, the boiler becomes fit cause for worry on the part of the owners and the operating force.

LAGONDA CLEANERS

The only way to keep a boiler safe and efficient is to clean it at regular intervals by mechanical means. This costs money. True. But it is a lot cheaper to remove it than to let it accumulate in the boiler.

Lagonda Cleaners utilize powerful air, steam or water-driven motors, with cutting heads most effective for the service. There is a type and size exactly suited for cleaning the tubes in any kind of boilers, water tube, or fire tube, straight tube or curved.

The Lagonda Mfg. Co.
SPRINGFIELD, OHIO.
FUEL SAVING SPECIALISTS

NEW YORK, CHICAGO, PHILADELPHIA, BOSTON, PITTSBURGH, CLEVELAND CINCINNATI, DETROIT, SYRACUSE, BALTIMORE. ST. LOUIS, KANSAS CITY, DENVER, DALLAS, ATLANTA, SAN FRANCISCO, MONTREAL, LONDON.

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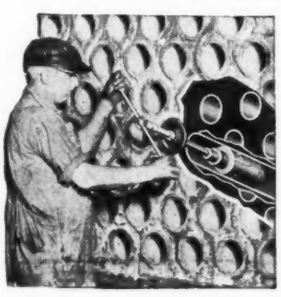


It's easy to cut out boiler tubes

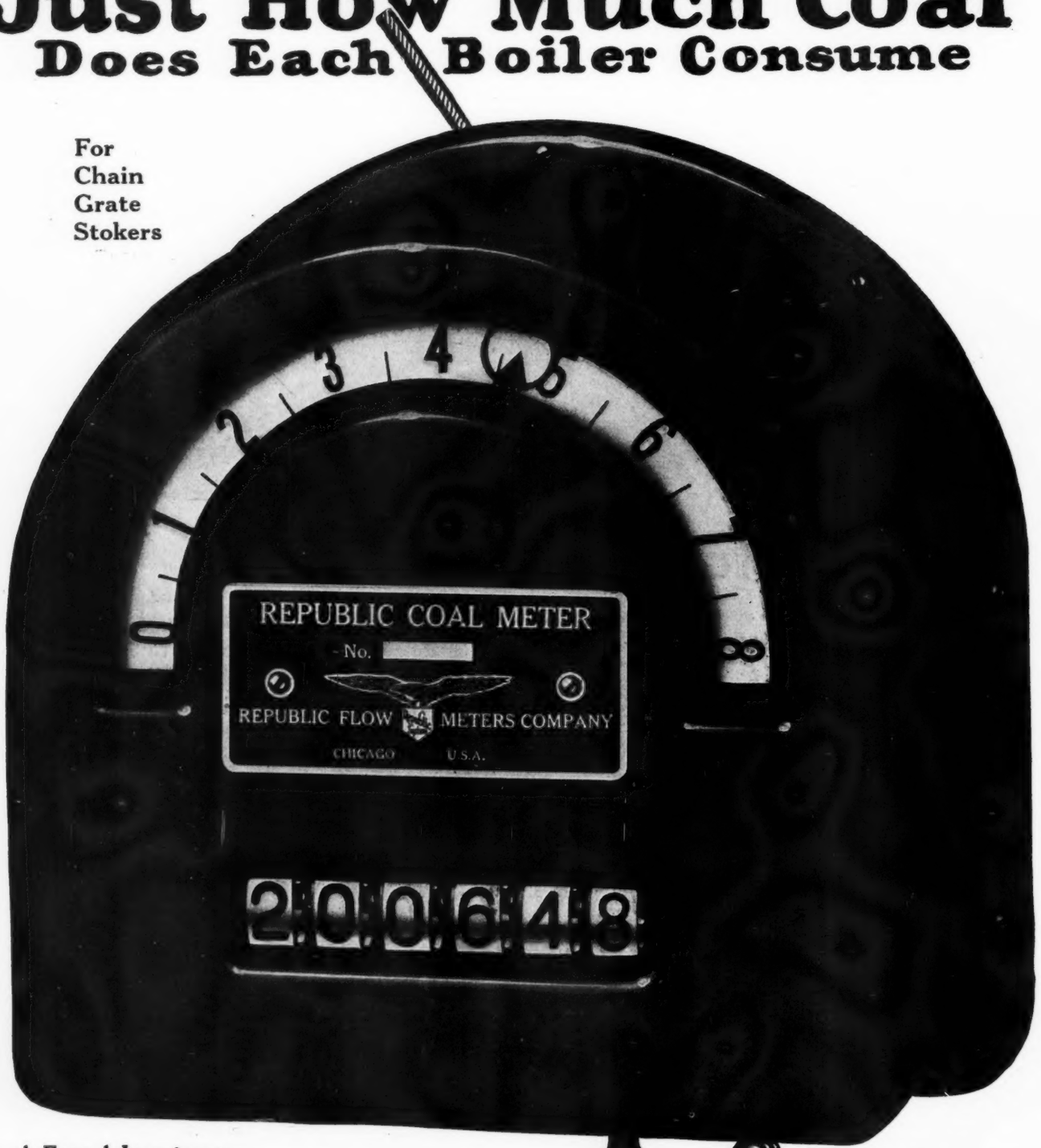
Cutting tubes with a Lagonda Tube Cutter is a simple and quick job. Tubes can be cut at any point, making a clean cut without a burr. A 4-in. tube can be cut off in a minute's time. One man operates it easily.

The correct way to clean up boiler caps

With a Lagonda Reseating Machine the operator simply passes from tube to tube and allows the emery or carborundum wheel to operate. Clamped in a vise, it is used for facing up caps. A great time and labor saver.

Just How Much Coal Does Each Boiler Consume

For Chain Grate Stokers



A Few Advantages—

(1) Will give a means of checking not only total coal consumption, but that of each boiler and stoker.

(2) Eliminate errors due to moisture—a check of one cubic foot will give the weight or B.t.u.'s per cubic foot, and therefore since the total actual volume is given by the meter—the total weight or B.t.u.'s—easily found.

(3) Aids in determining the particular combination of speed of grate and fire thickness for producing the best results.

(4) Easy to—read—test—install—can be accommodated to any type of chain grate stoker.

(5) No upkeep costs.

Write for Bulletin on "Measurement of Coal."

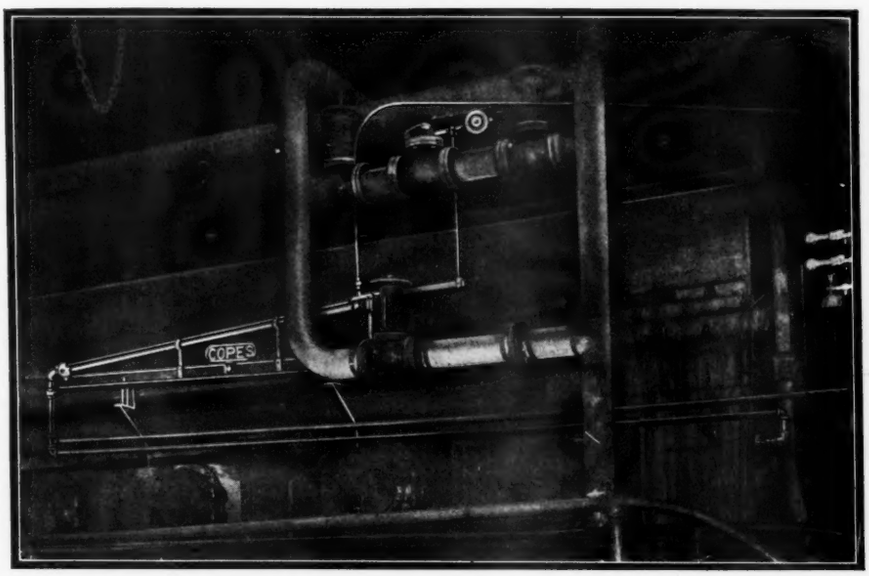
(6) With record of steam produced the lbs. of steam per lb. of coal can be determined and thus cost of 1000 lbs. of steam the ultimate measure of your boiler efficiency.

(7) Eliminates human element.

Republic Flow Meters Co., 2222 Diversey Parkway, Chicago, Illinois

Offices in 25 Principal Cities.

COPES Regulators are saving $14,000 each year for Consolidated Gas, Electric Light & Power Co.



At the Westport Station of the Consolidated Gas, Electric Light & Power Co. of Baltimore, all 52 boilers, ranging in size from 650 hp. to 1050 hp., are equipped with Copes Feed Water Regulators.

Mr. A. L. Penniman, Supt. of Steam Stations, says:

> ***"We installed our first Copes eleven years ago. They are an excellent investment, and so much more reliable than hand feeding. With hand feed the water level would vary greatly, and occasional slugs of water got over into the superheater, decreasing the temperature of the superheat, and resulting in less efficient operation.***
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> ***"With hand feed, four water tenders would be needed at this plant. With Copes, one water tender is required. The regulators thus save three men each shift, amounting to $14,000 each year."***

Copes Regulators save large amounts for large users, and proportionate amounts in a plant of any size. Small plants should have the benefits of Copes reliability, fuel and labor economy, and increased boiler efficiency, the same as larger plants. The investment is small, but the returns are large and constant.

Booklet "A" sent on request, gives all the facts about Copes Regulation.

SYSTEM OF BOILER FEED CONTROL

NORTHERN EQUIPMENT COMPANY
110 Grove Drive, Erie, Pa.

Branch Plants: Hamilton, Ontario, Canada; London, England; Paris, France; Merseburg, Germany; Vienna, Austria; Milan, Italy.

Bethlehem-Drysdale Pervac Pump

THIS is a vertical-shaft, two-stage, motor-driven pump for condensate extraction.

The vertical construction of the Bethlehem-Drysdale Pervac Pump enables the suction to be placed at the lowest possible point.

The two-stage arrangement is more stable and efficient than any single-stage arrangement. The first impeller is designed for best possible vacuum, while the second impeller deals with the external head and its efficiency is unimpaired by any consideration of vacuum.

The motor is bolted to the top of the pump so that the alignment is not affected by the expansion and contraction of the pipes.

A Complete Line of Power Plant Equipment

Turbo-Feed Pumps, Reciprocating Feed Pumps, Fuel Oil Transfer Pumps, Forced Lubrication and General Service Pumps.

Turbine- and Motor-driven Feed, Condensate and Centrifugal Circulating Pumps, Motor-driven Centrifugal Service Pumps.

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Regenerative Condensers

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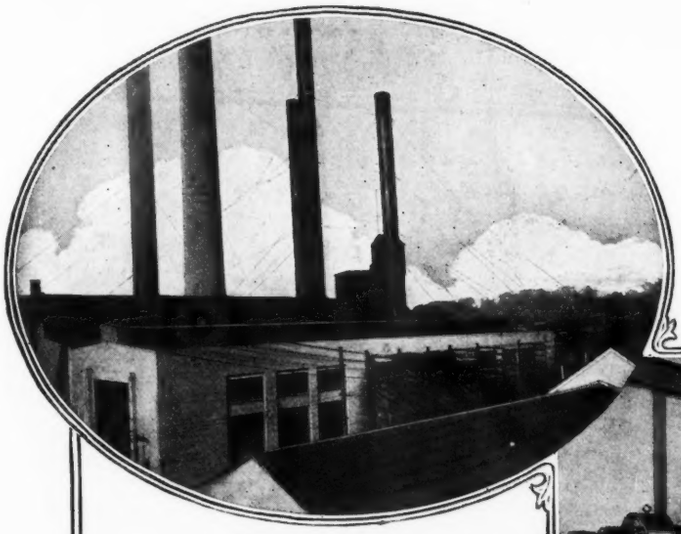
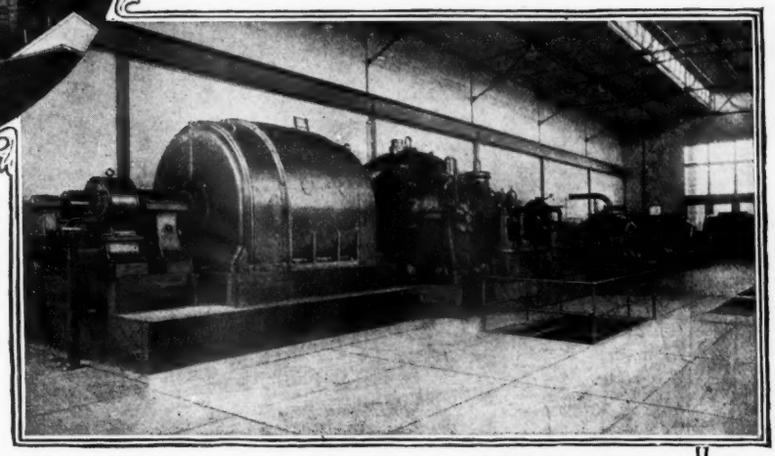


Ohio Edison Company
equipped with Tracy Steam Purifiers



Turbine Room of
Ohio Edison Company

In less than one year the Tracyfier has more than paid for itself!

We have heard that remark many times. It is a significant fact that all users of Tracy Steam Purifiers have said the same.

The Tracy Steam Purifier guarantees absolutely clean and dry steam. When purified by the Tracyfier, steam is much more easily superheated. The superheaters are efficiently protected against foreign solid matter coating the tubes and hurling itself with the issuing steam against the turbine blades.

CLEAN STEAM · TRACYFIER · DRY STEAM

Tracy Steam Purifiers

(Tracyfiers)

in more than 4,000 installations have been affording their users great satisfaction. Fuel costs are being reduced by hundreds of dollars per year. The life-time of super-heater tubes is being materially lengthened and there are fewer cleaning and repair jobs to retard the efficient functioning of the boilers.

We have abundant proof of Tracyfier performance. The return of the coupon will bring it to you.

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530 Fourth Avenue

Pittsburgh, Pa.

Andrews-Bradshaw Co.,
530 Fourth Avenue, Pittsburgh, Pa.

Dear Sirs:
Your Power ad of Dec. 30 sounds interesting.—tell us more about your Tracyfier.

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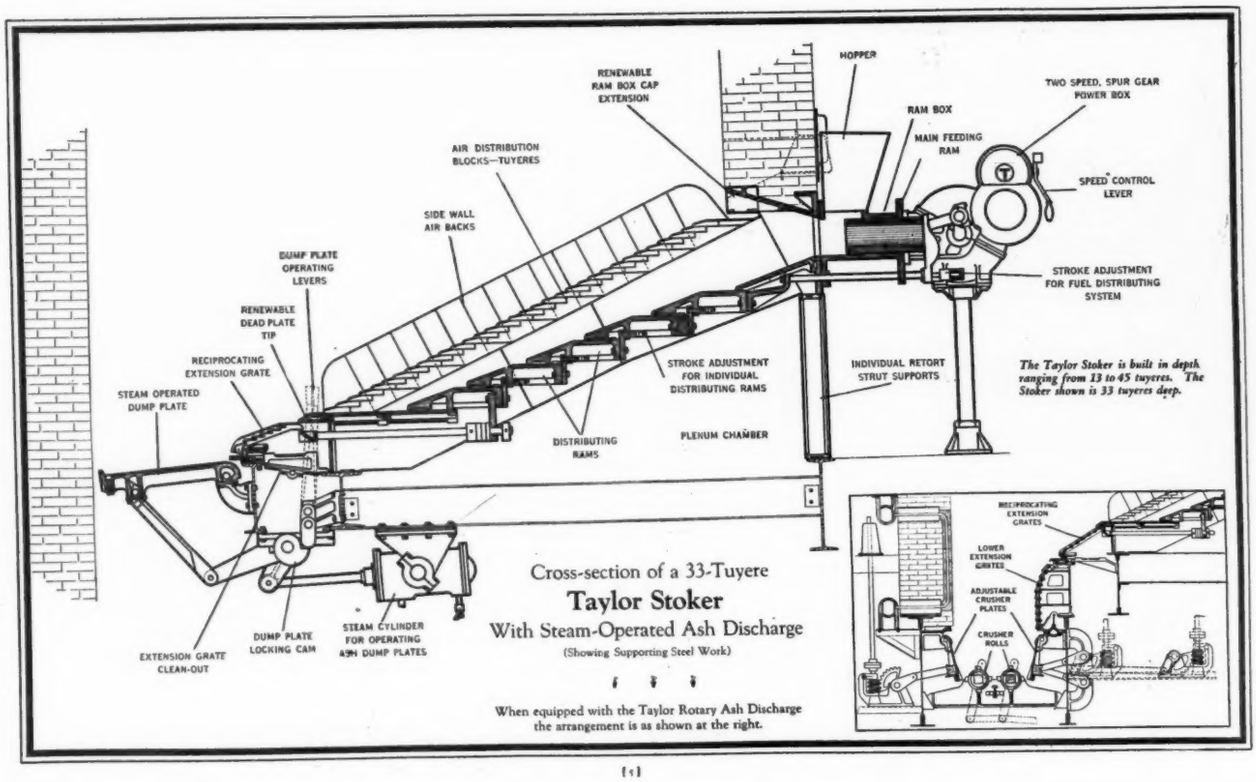
Address .....



The Taylor Stoker is built in depth ranging from 13 to 45 tuyeres. The Stoker shown is 33 tuyeres deep.

Cross-section of a 33-Tuyere

Taylor Stoker

With Steam-Operated Ash Discharge

(Showing Supporting Steel Work)

When equipped with the Taylor Rotary Ash Discharge the arrangement is as shown at the right.

[1]

The **Taylor Stoker**

American Engineering Company
Philadelphia

A double page from the new TAYLOR catalog

This book gives to every Executive and Engineer, concisely and clearly, the many radical developments that have resulted in the establishment of new standards of fuel burning efficiency and capacity.

The coupon is for your convenience in requesting a copy.

Mail it now!

Do you know the many new and radical developments that made The Taylor Stoker the simplest, most efficient and most economic system of combustion?

What system of combustion can equal this for

Adaptability to Existing Plant Conditions?

Built in 125 sizes there is a Taylor to meet the requirements of existing plants desiring better efficiency and capacity from the same boiler equipment, including those with boilers already set low.

—and the Taylor Stoker is the straight line system of combustion. No coal preparation.

American Engineering Company
Aramingo and Cumberland Sts., Philadelphia

Manufactured in Canada by
TAYLOR STOKER CO., LTD., Toronto, Ont.

Principal Sales Office:
416 PHILLIPS PLACE, MONTREAL, QUE.

AMERICAN ENGINEERING COMPANY
Aramingo and Cumberland Sts., Philadelphia

Gentlemen:
Without any obligation to me
☐ Send the New Taylor Stoker Catalog.
☐ Send the booklet on the Hell Gate Tests.
☐ Send an Engineering Representative.

Name.....
Company.....
Address.....
Date

Your stockroom is in t

Select Your Packings From This Chart

CONDITIONS	RODS AND PLUNGERS (Reciprocating and Oscillating)		ROTATING RODS & Shafts	PISTONS (inside packed)	SHEET PACKING
	Packing Space ⅛ in. or more	Packing Space less than ⅛ in.			
STEAM	Sea Rings or Kearsarge	Mogul	Mogul		Service
HOT WATER	Sea Rings or Duplex	Mogul	Mogul	Universal	Service
COLD WATER	Sea Rings or Duplex	Mogul	Mogul	Universal	Service
AIR	Sea Rings or Kearsarge	Mogul	Mogul	Universal	Service
AMMONIA	Kearsarge	Mogul	Mogul	Universal	Service
BRINE	Sea Rings or Duplex	Mogul	Mogul	Universal	Service

Boiler Manhole and Handhole Plates—Kearsarge Gaskets

NOTE:
The seven packings listed can be used for many conditions not given above. Some of them may be used for Oils, Asphalts, Gasoline, Gas, and various chemical fluids. For such conditions, however, we prefer to make a specific recommendation based on exact knowledge of the kind of fluid, its temperature, pressure, and other important factors. Refer such problems to our nearest branch.

Johns-Manville issues a publication called "The Power-Specialist," in which users tell how they have saved power and money with Johns-Manville Power Specialties. We will gladly add your name to the mailing list upon request.

JOHNS MANVILLE SERVICE
COVERS THE CONTINENT
Through
Asbestos
and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

JOHNS-

Power

the packing business

Run it in the business-like way

THE business-like way means the economical way, cutting down your overhead investment and reducing waste space in the stockroom as well as getting longer and more efficient service from your packings in the plant. Your packing shelves can help in this, when they are stocked with Johns-Manville Packing. For, instead of numerous and sundry packing styles, the seven Johns-Manville Packings shown on the right fully meet every need in your plant. This releases stockroom space—and invested capital.

And these packings save money in the plant. They last longer than other packings under the same conditions. One of our Kearsarge Gaskets, for example, was removed and remounted 96 times over a period of many years—at a cost of 1c per time. This sort of durability is found in all Johns-Manville packings. Consult the chart when you want to know the right packing for your purpose, and remember that with packing—as with everything else—standardization, as offered to you here, is the business-like way.

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Branches in 62 Large Cities. For Canada: Canadian Johns-Manville Co., Ltd., Toronto

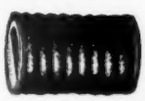
Service Sheet Packing
A dense resilient sheet packing that will pack almost anything from mercury vapor to molasses

Sea Ring Rod and Plunger Packing
Constructed on a unique scientific principle which saves wear on both the packing and rod and saves power besides.

Kearsarge Rod Packing
For steam or air at any temperature or pressure.

Duplex Rod Packing
For water at any temperature or pressure.

Universal Piston Packing
The back and forth folded construction presents folded edges to the cylinder wall—giving much longer wear.

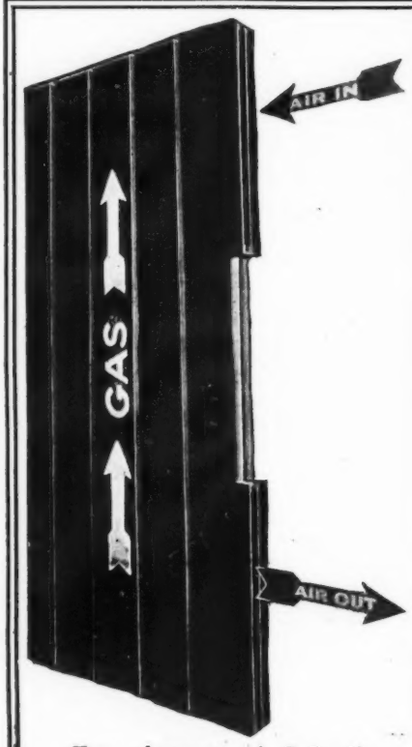


Mogul Coil Packing
Contains no rubber—furnished in twisted or braided form.

Kearsarge Manhole Gaskets
Asbesto-Metallic fabric folded so that double edge is presented to the pressure. Can be removed and replaced many times.

MANVILLE
Plant Materials

Make stack gases and f



Two elements of C-E Air Heater as they are arranged when installed in casing. A complete heater consists of the required number of elements assembled in a single casing. Arrows indicate flow of gas and air.

C-E Fin Furnace walls replace furnace wall maintenance charges with steam producing walls.

C-E Fin Furnace walls are composed of water tubes connected in the boiler circulation.

Evaporation is increased and efficiency improved.

INTERNATIONAL COMBUSTION

Combustion Engi

Combustion Engineering Bldg

Offices in Principal Cities

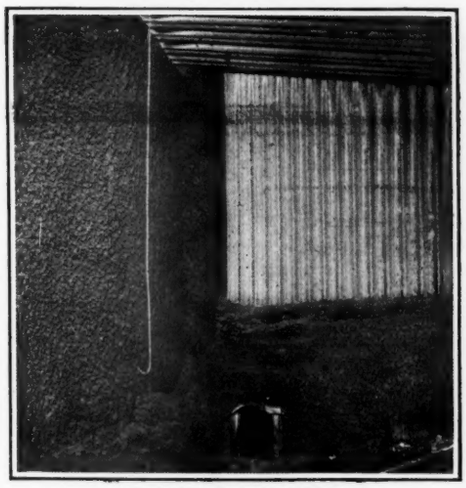
Frederick Multiple Retort Stokers
Type E Stokers
Type D Stokers
Type K Stokers
Type H Stokers
Self Contained Stoker

INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

furnace walls work for you

With C-E Air Heaters installed, the gases that formerly escaped up the stack are put to work. They transfer their heat units to the air supplied for combustion. Increased efficiency and capacity result.

Ordinary Furnace Wall



C-E Fin Furnace Wall

ENGINEERING CORPORATION

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43 Broad Street New York City

Throughout the World

Green Chain Grate Stokers
Green Cast Iron Hoppers
Green Pressure Waterbacks
Quinn Fuel Oil Equipment
C-E Fin Furnace

Lopulco Pulverized Fuel Systems
Coxe Stokers
Grieve Grates
C-E Air Heaters
C-E Tube Scraping Device
Combusco Water Seal Conveyor

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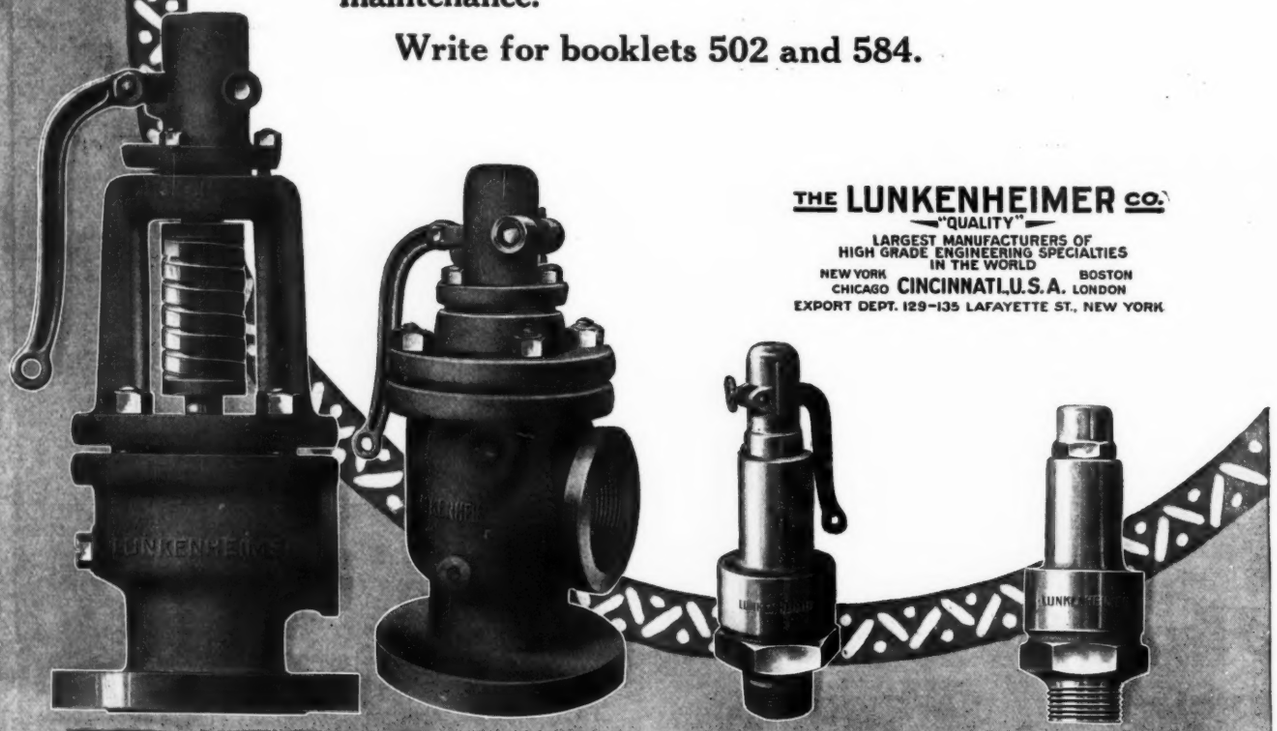
Pop Safety and Relief Valves

A most extensive line of a large number of designs made in various combinations of materials, permitting of a broad choice for any service, pressure or temperature.

Reliable, durable and economical in operation and maintenance.

Write for booklets 502 and 584.



THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF HIGH GRADE ENGINEERING SPECIALTIES IN THE WORLD
NEW YORK CHICAGO CINCINNATI, U.S.A. BOSTON LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

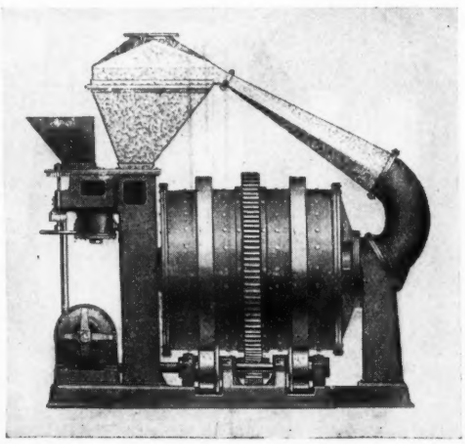
Fig. 146 Iron Body Bronze Mounted Outside Spring Pop Safety Valve	Fig. 630 Iron Body Bronze Mounted Encased Spring Pop Safety Valve	Fig. 433 Bronze Encased Spring Top Outlet Pop Safety Valve	Fig. 656 Bronze Encased Spring Top Outlet Cylinder Relief Valve

"America's Best since 1862"

4-24-42

BONNOT *Unit-Air* BALL MILL

The BONNOT *Unit-Air* Ball Mill is a real "step ahead" in pulverized coal equipment.



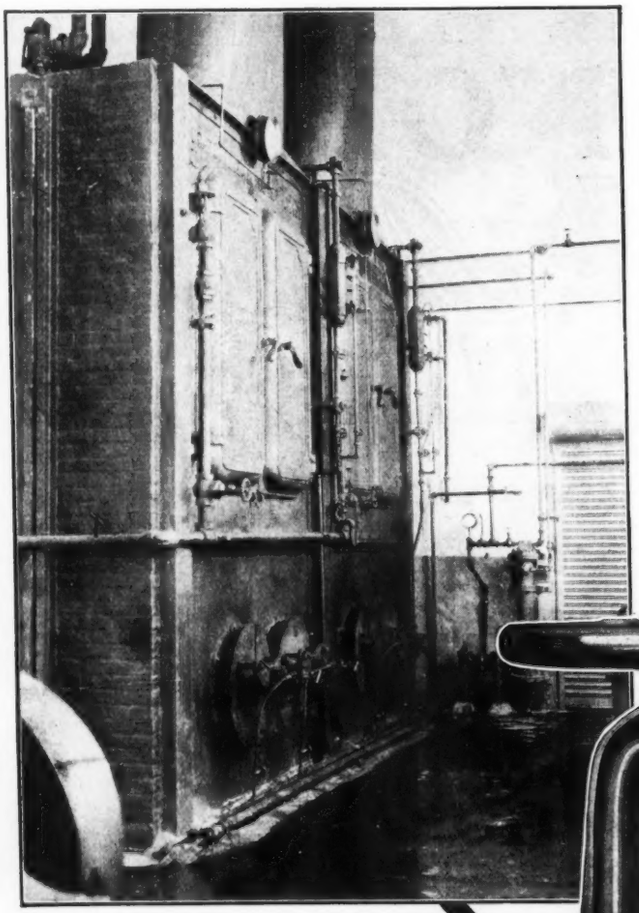
It combines the recognized advantages of **ball mill grinding** with **air separation**—made efficient and practical by **interior classification**—an entirely new and original feature, broadly covered by patents.

Briefly, the *Unit-Air* operates at **low speed** averaging less than 30 R.P.M.; is not subject to injury from tramp iron; has no expensive grinding parts to renew; produces a uniform product with very economical power consumption and can absolutely be depended upon for **continuous operation** over a long period.

If you are considering pulverized coal firing for your boilers, write for data on the Unit-Air! There is no obligation.

The Bonnot Company

CANTON, OHIO.



"We cannot af
most substan-tia

At the left are shown H. R. T. boilers made by Coatesville Boiler Works, Philadelphia, who have adopted YARWAY TANDEM BLOW-OFF VALVES as standard equipment.

Below is shown the YARWAY TANDEM, the ideal equipment for any boiler and any pressure. Unconditionally guaranteed for two years.

YARWAY

TANDEM
BLOW-OFF
VALVES

YARWAY POWER PLANT D

YARWAY BLOW-OFF VALVES—YARWAY SPRAY N

afford to employ anything but the tial and correct Blow-Off Valves"

—*They've standardized on YARWAY*

COATESVILLE BOILER WORKS

Boilers and Steel Plate Construction

COATESVILLE PHILADELPHIA NEW YORK BOSTON

142 CHESTNUT ST
PHILADELPHIA

July 21, 1924.

Yarnall Waring Company,
Chestnut Hill, Phila., Pa.

Gentlemen:

In reply to your recent request relative to the use of Yarway Valves on our boilers. We have been carefully investigating the most suitable combination of valves to use and have selected your equipment, not because we continually run across them in operation in many of the most important installations throughout the Country, but because the constructive features appealed to us as fundamentally sound.

We believe that Blow-off service is perhaps the most trying that a valve will have to work under and our feeling is that we cannot afford to employ anything but the most substantial and correct material for this purpose, not only from the point of view of maintenance but for the sake of safety.

Yours very truly,
COATESVILLE BOILER WORKS.

CE-MoC

President Board of Directors

IN THE letter reproduced at the left, Mr. Charles Edgerton, president of the board of directors of Coatesville Boiler Works, states his opinion of the importance of blow-off valves, and the reasons why Yarway Tandem Blow-Off Valves are furnished as standard equipment on Coatesville Boilers.

Thirteen other boiler manufacturers, making every type of boiler used in modern power plants, have shown the same attitude by factory - equipping their products with Yarway Blow-Off Valves.

Boiler manufacturers who furnish Yarway Blow-Off Valves as standard equipment include:

Badenhausen Boiler Co.
Bigelow Co.
(*Use Yarway Seatless as Master Valves*)
Casey-Hedges Co.
(*On all water-tube boilers*)
Coatesville Boiler Works
R. D. Cole Manufacturing Co.
D. Connelly Boiler Co.
Edge Moor Iron Co.
Freeman Manufacturing Co.
International Engineering Works
Kingsford Foundry & Machine Co.
Samuel Smith & Son Co.
Springfield Boiler Co.
(*On high-pressure boilers*)
Union Iron Works
(*Use Yarway Seatless as Master Valves*)
Walsh & Weidner Boiler Co.

Yarway Blow-Off Valves are also largely used by boiler manufacturers not mentioned in above list.

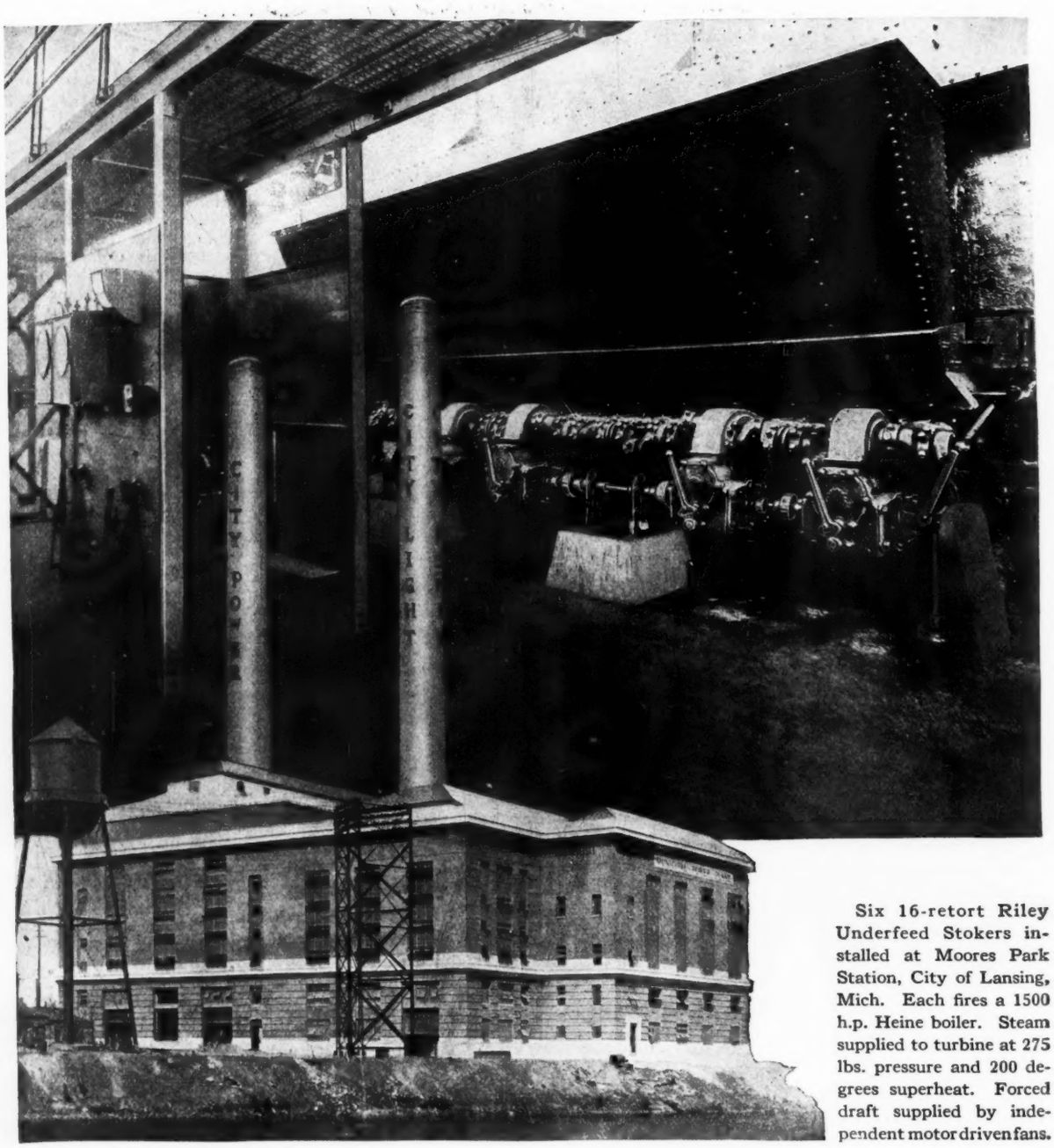
Write for Booklet B-410A

YARNALL-WARING COMPANY
Mermaid Avenue
PHILADELPHIA

T DEVICES *to save fuel*

RAY NOZZLES—YARWAY-LEA V-NOTCH METERS

Lansing—A Station



Six 16-retort Riley Underfeed Stokers installed at Moores Park Station, City of Lansing, Mich. Each fires a 1500 h.p. Heine boiler. Steam supplied to turbine at 275 lbs. pressure and 200 degrees superheat. Forced draft supplied by independent motor driven fans.

SANFORD RILEY STOKER COMPANY

SANFORD RILEY STOKER

"RILEY" Underfeed Stokers *"JONES" Underfeed Stokers* *"MURPHY" Automatic Furnaces*

PULVERIZED COAL INSTALLATIONS

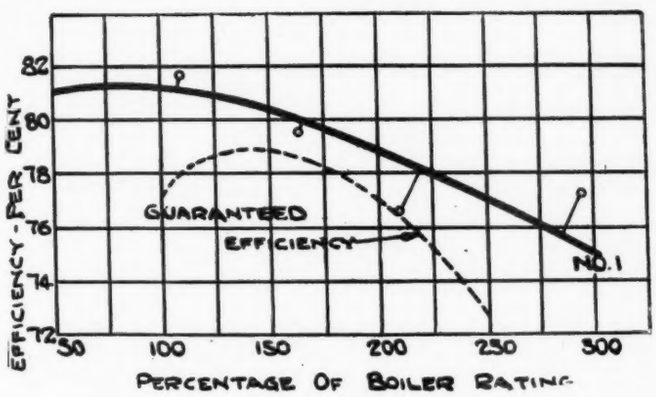
# of High Economy

Excerpts from article by J. E. Woodwell—POWER—September 16, 1924.

"The new municipal power plant (Moores Park Station) for the City of Lansing was designed to secure a high **economy of operation** combined with sufficient flexibility to meet the seasonable fluctuations from the larger industrial plants, among which the automotive industries predominate..... ....."

SUMMARY OF TEST RESULTS

"The efficiency ranged from 81.3 at 100 per cent rating to 78.9 at 200 per cent rating, which was only lowered to 75 per cent at the 300 per cent rating, thereby exceeding the guarantee by a substantial margin, as shown on curve No. 1."



"...the average combined boiler and stoker efficiency for the month of June being 79.8 per cent at an average load of 129 per cent."

Riley Underfeed Stokers fire all the boilers at the Lansing Municipal Plant.

These results and those obtained in many other well known plants using the simple, improved Riley Stoker are significant in setting enviable marks for over-all plant economy.

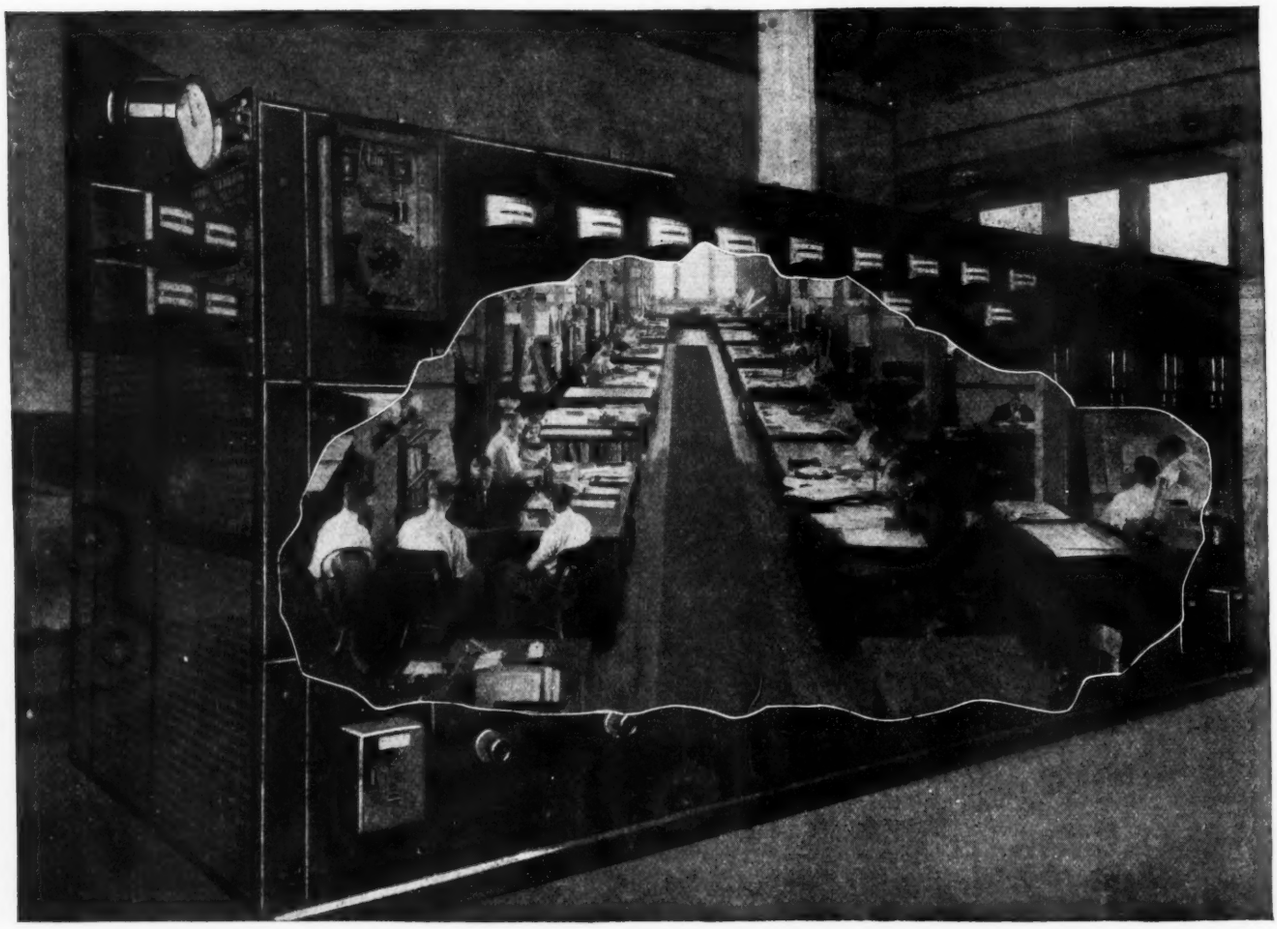
You should have a copy of these complete test results. Ask for Bulletin on Lansing Station

COMPANY, Worcester, Mass.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT
CINCINNATI CHICAGO ST. PAUL KANSAS CITY DENVER CHARLOTTE DALLAS

The UNDERFEED STOKER COMPANY OF CANADA, LTD., TORONTO.

SANFORD RILEY STOKER COMPANY



Back of every G-E Switchboard is a responsible engineering organization.

At your disposal— the experience of the pioneer

The switchboard is assuming more and more responsibility. Its importance grows with the ever increasing quantities of power—the multiplied and diversified distribution circuits—that it must control. Its keystone position in the plant makes correct design, and quality, likewise of great importance.

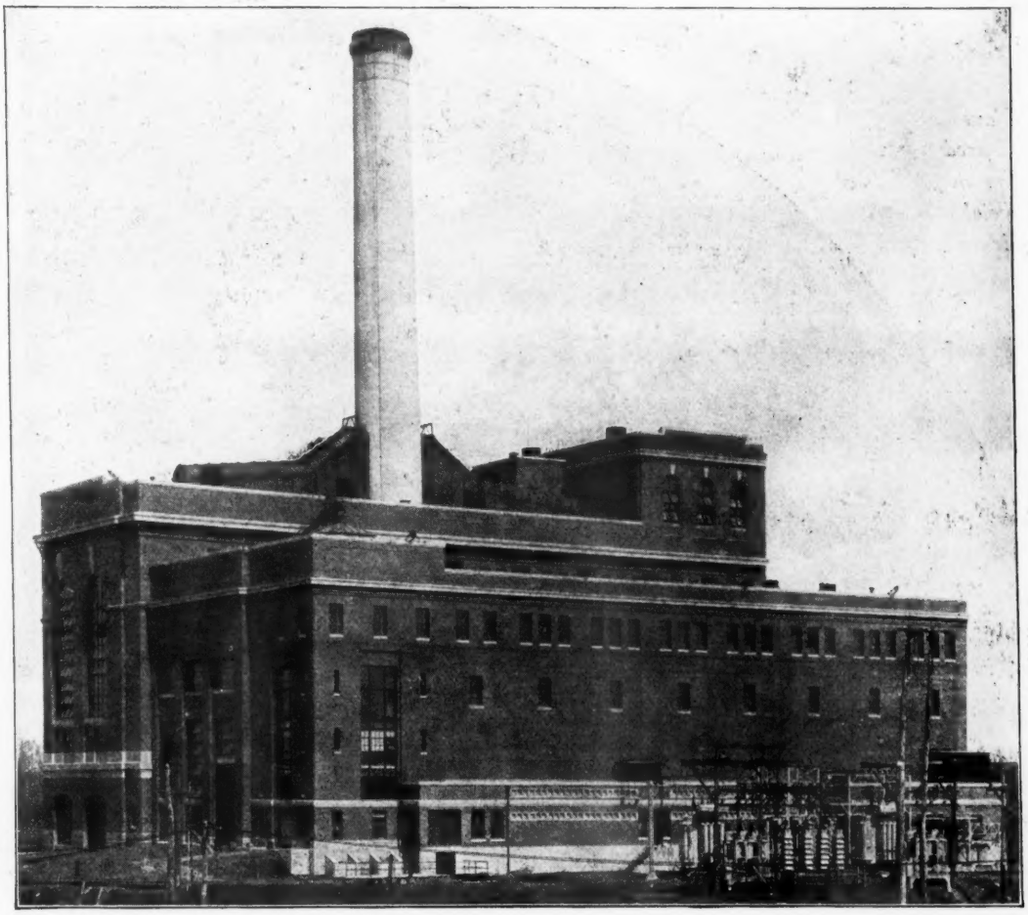
In switchboard engineering—and building—General Electric is the pioneer. The known excellence of its product has gained the confidence of the most discriminating buyers of power apparatus.

By experience with switchboard problems of most varied character G-E switchboard engineers are eminently well fitted. They will advise as to any switchboard project, large or small. They serve the interests of builder, investor, operator and power consumer.

54C-97

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN ALL LARGE CITIES



South Meadow Station, of the Hartford Electric Light Co., Hartford, Conn. Stone & Webster Engineers.

The Hartford Electric Light Company has always displayed the splendid spirit of the courageous pioneer. It was the first public utility to use the steam turbine of large capacity in America, back in 1902. Now it is making history by trying out the mercury-vapor cycle in a plant intended to carry a commercial load. All engineers recognize in South Meadow a power station of exceptional merit, wherein all details of design and operation have been thoroughly thought out. Bowser is proud that its Richardson-Phenix oil purification equipment is used there.

Our new booklet, "Representative Power Plants" may be had from Dept. 6.

BOWSER ESTABLISHED 1885

S.F. BOWSER & COMPANY, Inc.

LUBRICATION ENGINEERS AND MANUFACTURERS

FORT WAYNE, INDIANA, U.S.A.

McClave Hand-fired Stokers in a Special Application

The

McClave Engineers are ready for your power problem—not with a ready-made answer, but with the skill and experience to analyze your conditions and to develop the means to meet them in the most economical way.

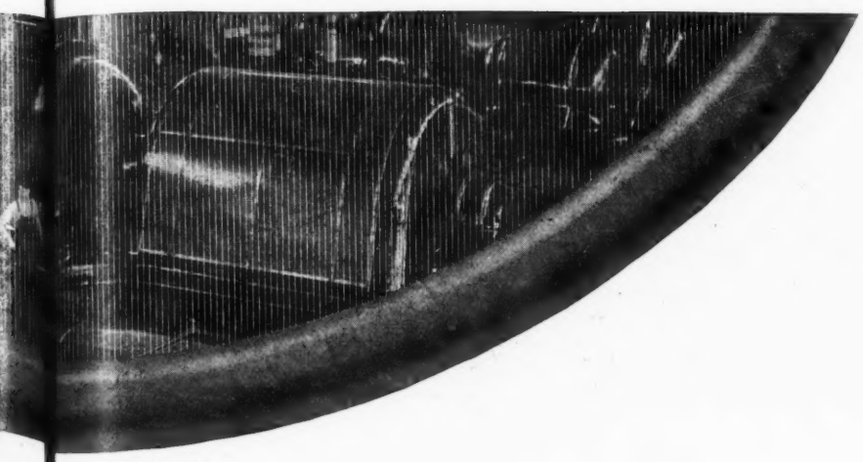
McClave

GRATES
STOKERS
STEAM
BLOWERS

Trade Mark

Reg. U. S. Pat. Off.

McClave COMBUSTION



link that must be strong

McClave

Between coal mine and turbine—between the source of power and its application—*there* lies the important link in the power chain. Economical power depends on it. Knowing this, hundreds—thousands—of power plants make that link of McClave Combustion Systems. Whatever their source of power—high grade, medium or lowest grade coals, slack or screenings, bagasse or any combustible refuse, there is sure to be a McClave Combustion System, developed by McClave engineers to meet the particular problem, stoutly holding its own and providing the most economical conversion of fuel into steam.

McClave Products

Mechanical Stokers
Hopper-Feed Hand Stokers
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Anthracite Stokers (Type M-A)
Shaking Grates
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McCLAVE-BROOKS COMPANY

Sole Makers of the Famous McClave Grates Since 1883

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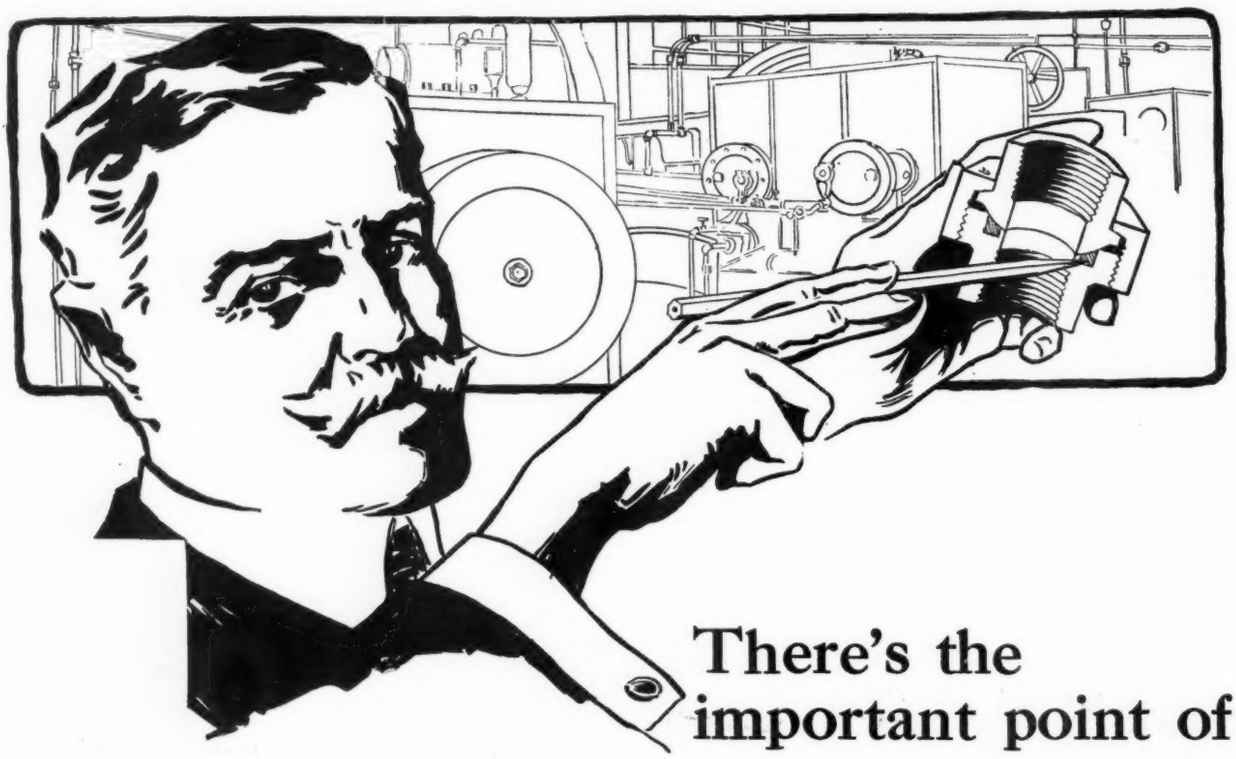
SYSTEMS *for greater economy*

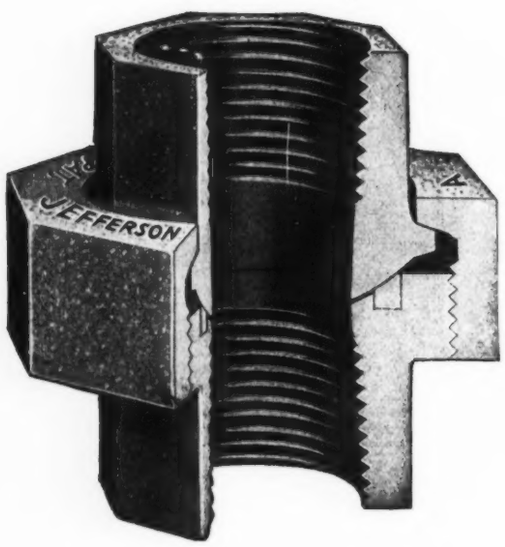


There's the important point of *Jefferson Unions*

The point noted is the brass seat ring — located back from the runway of the fitting. This fully protects it from the scouring or abrasive action of the pipe contents. It is pressed into its channel and is not affected by the difference in expansion and contraction of brass and iron.

Another feature is the brass-to-iron ground ball joint. This is a strong point in "Jeffersons"—the Jefferson method of manufacture makes it so. The male and female parts are first machined to a true arc, then ground in pairs, and never after separated. They always fit.

Incidentally, the ball joint, with the sloping shoulder, makes these Unions self-seating under even difficult conditions. This makes tight joints even though the piping is somewhat out of line.



"Look for the name on the Nut"— to be sure you're getting the genuine.

For further information get a copy of our catalog. Then order from your dealer.

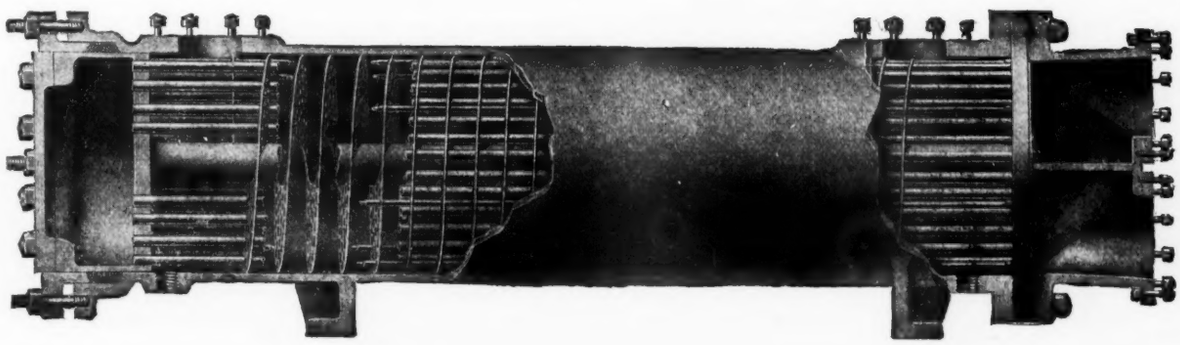
The Jefferson Union Company

Lexington, Massachusetts

Cool Turbine Oil

Made Continuously Available by

MULTIWHIRL COOLERS



Over 2000 in Use

Some of the applications are as follows:

Cooling lubricating oil
Cooling transformer oil
Cooling quenching oil
Water to water heat exchanger
Recovery of heat from waste liquors
Oil to oil heat exchanger
Condensing and subcooling of gasoline and solvent vapors

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For Canada: Riley Engineering Co., Ltd., Toronto

The Griscom-Russell Company
90 West Street, New York
Gentlemen:
Please forward immediately a free copy of your Bulletin No. 904.

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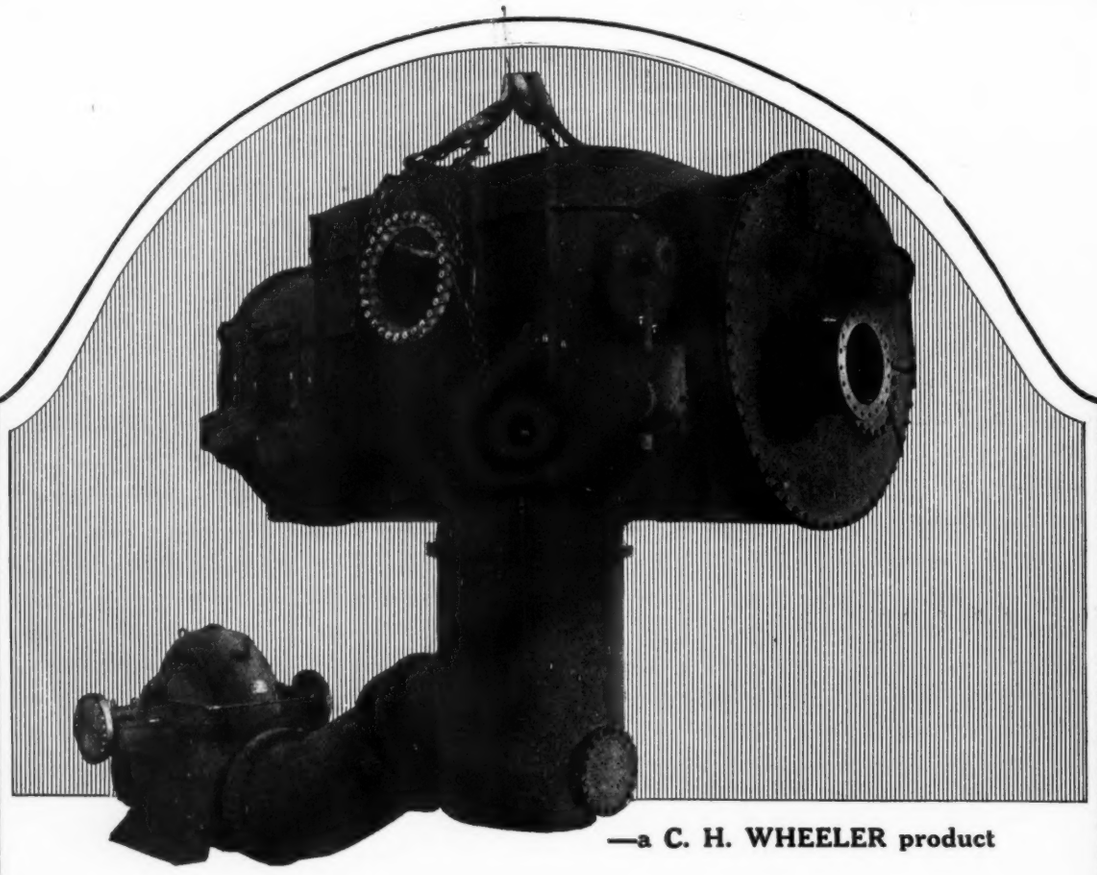

—a C. H. WHEELER product

A special design that proved itself—

Five of these C. H. Wheeler Low Level Jet Condenser Units are now in service. The illustration shows one of two 15,000 kw. units at the Tiger Steam Station of the Southern Power Company. Two similar units are at the Mount Holly Station of this company and the fifth is located at University, North Carolina.

If your plant offers an unusual condenser condition, let us know the facts. We are fully prepared to offer a special design, if required. Write us for particulars.

C. H. WHEELER MFG. CO.
19th St., Lehigh and Sedgley Aves.
PHILADELPHIA, PA.

Ask C.H.Wheeler of Philadelphia about
Surface Condensers
Jet Condensers
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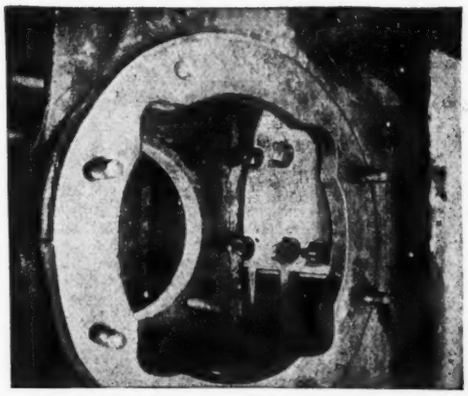
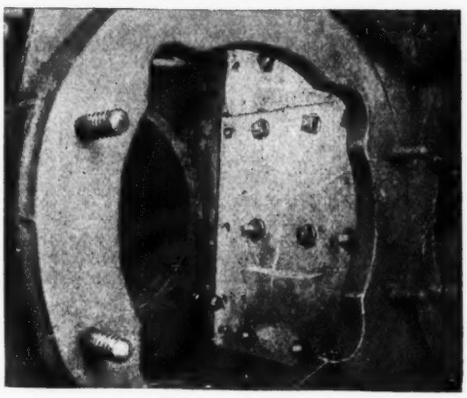
Vacuum Pumps
Exhaust Connections
Cooling Towers

"C.H.Wheeler of Philadelphia"

A duplex pump thought beyond repair—perfectly restored with SMOOTH-ON No. 1





The new SMOOTH-ON Handbook is filled with ideas on common-sense power apparatus repairs. Get your copy and post yourself on latest practice. Mailed free if you return the coupon.

AT the plant of Wm. Davis Co., Toronto, Ont., a crack developed at the rear end of the partition wall between the plunger chambers of a 12x8½x12-in. duplex brine pump.

As the crack gradually became worse, the pump efficiency kept on decreasing, and although the steam end was still in good condition, the management practically decided that the pump had to be scrapped.

In the hope of salvaging it, the partition was first electrically welded and new valve seats were put in. The pump then started apparently in good shape, but within a week the weld gave way.

As considerable money had been spent on the new seats, a final effort was made to save the pump. The partition was knocked out entirely, the top cover taken off the valve deck and ⅝-in. holes drilled through over the partition. An extension drill was then used to drill ⅝-in. tapped holes in the lower part of the partition strip and ⅝-in. rods were put through the top holes and screwed into the bottom holes, with nuts and washers tightened down on the top valve deck. Two plates of No. 10 gauge galvanized sheet iron were then bolted onto each side of the rigid bars, as shown in the first picture. The plates were a little wider than the partition, but only three-quarters the length, as it was impossible to get a full length plate through the back cover opening. The space between the plates was filled with lead, the bottom section poured first, then the top plates put on and the top section poured through a hole in the top valve plate.

The plates were then taken off and the solid wall of lead smeared over with SMOOTH-ON No. 1 on each side, and the plates put on again with washers on the through bolts drawing them together and making a tight partition wall. The completed job is shown in the second picture.

This SMOOTH-ON repair was reported to us as satisfactory and in perfect condition after three months continuous service and there is every reason to believe that it will add many years to the pump life.

Buy SMOOTH-ON No. 1 in 7-oz., 1-lb., 5-lb. or 10-lb. can from your nearest supply house or if necessary, from us direct.

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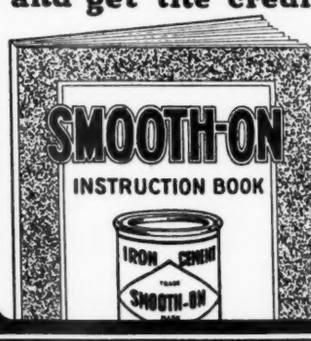

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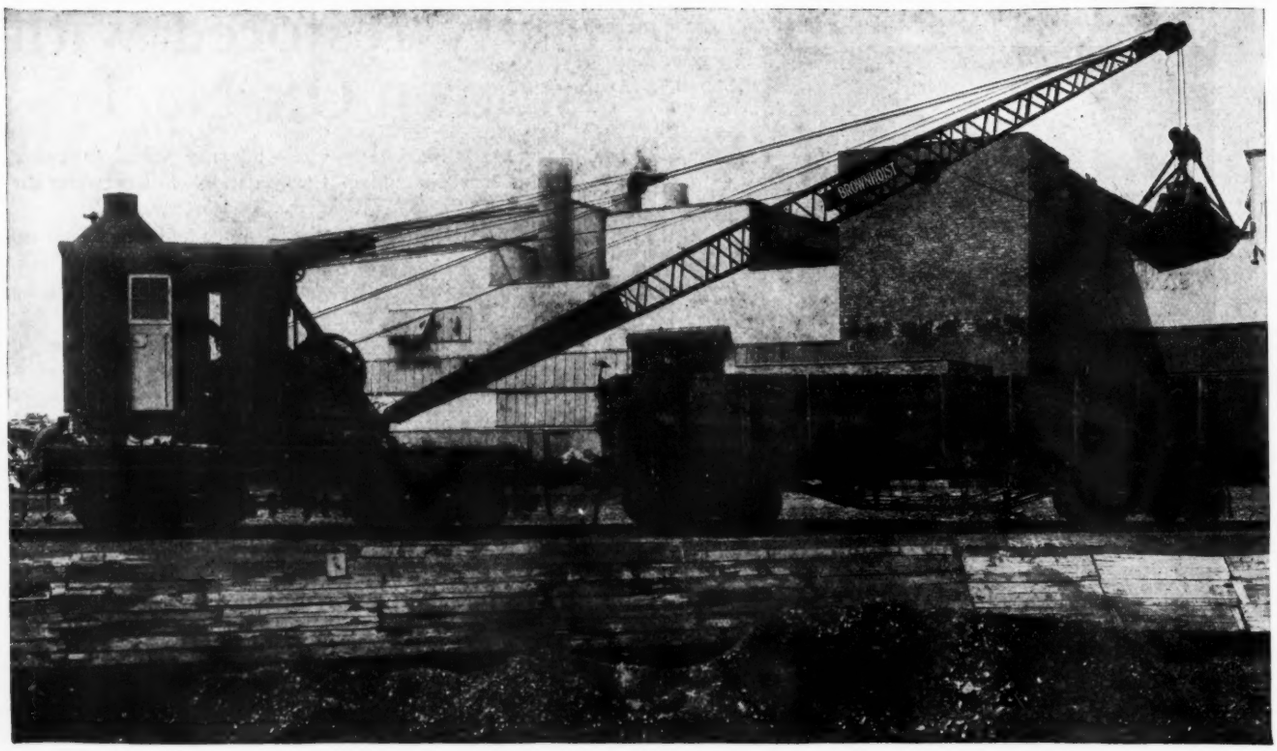

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PARTS OF MULTIPORT VALVE

The important parts of the Cochrane Multiport Valve are built to limit gages and are interchangeable. Materials and workmanship are of the highest quality throughout.

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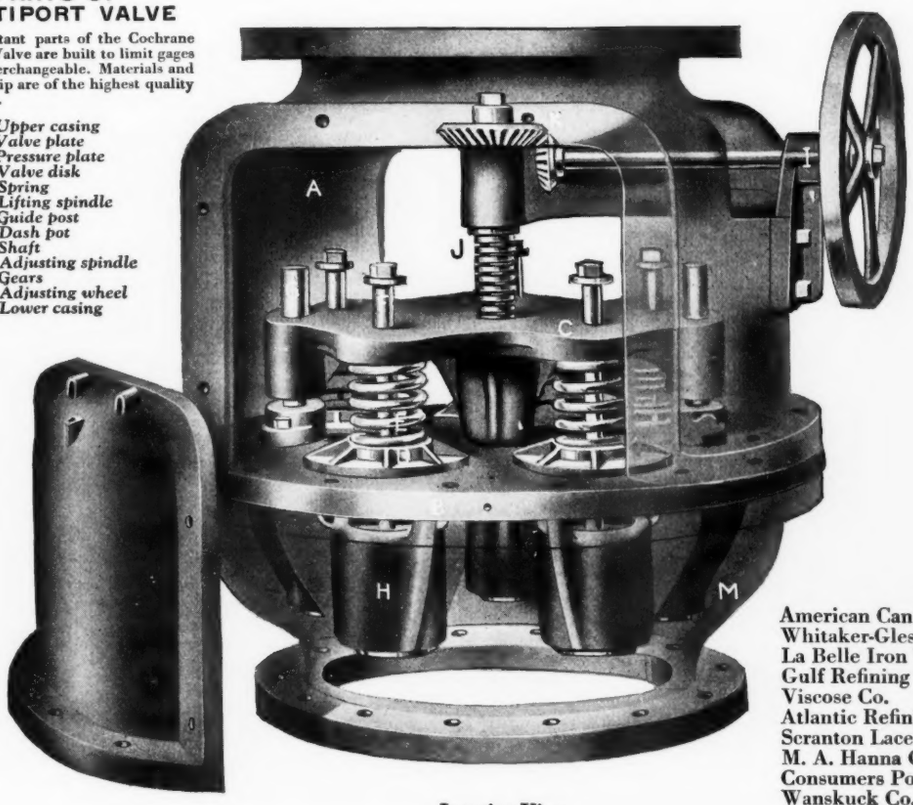
B *Valve plate*
C *Pressure plate*
D *Valve disk*
E *Spring*
F *Lifting spindle*
G *Guide post*
H *Dash pot*
I *Shaft*
J *Adjusting spindle*
K *Gears*
L *Adjusting wheel*
M *Lower casing*



Interior View

A Safety Valve for the Exhaust Steam System

THE Multiport construction facilitates building Valves in any size, without introducing the difficulties inherent in large disks and seats, or heavy moving parts.

This and other advantages of the Cochrane Multiport have appealed to engineers of large plants, as will be apparent from the following list of some of our Multiport customers:

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VALVES
Back Pressure
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SEPARATORS
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TRAPS
Low Pressure
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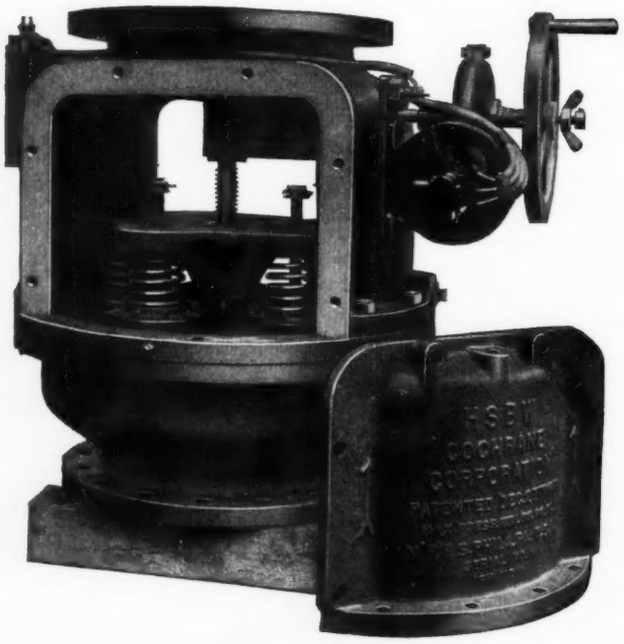
Possesses the following unique advantages:



Cochrane Multiport Valve
Motor operated for remote control

Cochrane Multiport Valve with vertical inlet and horizontal outlet

Cochrane Multiport Valve for Horizontal Pipes

1. Many small disks instead of one large disk. No possibility of all sticking at once.
2. Exceptionally large exhaust area in a valve of moderate dimensions. The Multiport offers 100 per cent. more aggregate disk circumference than any other back pressure valve.
3. Much less lift is required, since a valve disk needs to lift only one-quarter of its diameter to give full opening.
4. Lighter disks, together with shorter lift, result in much less hammering of seats.
5. Efficient dash pots, one for each disk, eliminate rattle and hammering altogether. The dash pot is bored at the same setting with the seat, insuring alignment.
6. The disks are held to seat by springs having little inertia.
7. The back pressure is easily and quickly regulated or the disks can be lifted from their seats for free exhaust by adjusting the position of the pressure plate by means of a handwheel, chain or electric motor.
8. The travel of the pressure plate is limited, so that the back pressure cannot be increased above a certain predetermined maximum. There is no way in which the valve can be overweighted or tied shut.
9. No moving part connected directly to the disks extends outside the casing, hence there is no possibility of obstruction by external parts or of jamming, as by overtightening of packing glands.
10. The individual disks are removable through doors, or can be ground to seat while in place. A small disk is more easily fitted to its seat than is a large one, and the smaller the disk the less will distortion by heat affect the fit.
11. Multiport Valves are built in forms adapted to horizontal, vertical and angle pipes, for both atmospheric relief and back pressure service.
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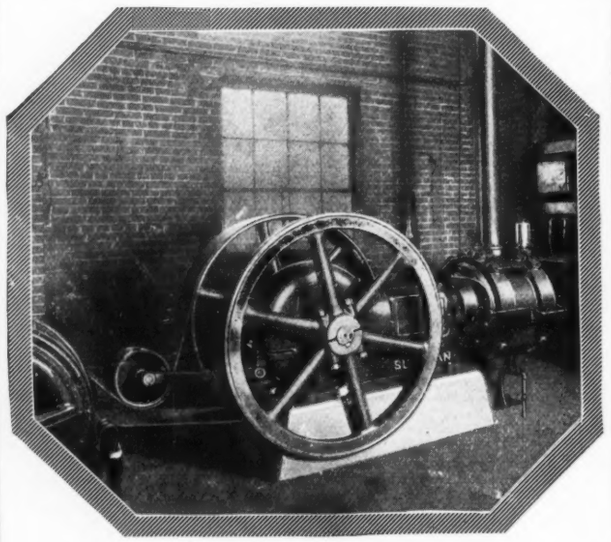

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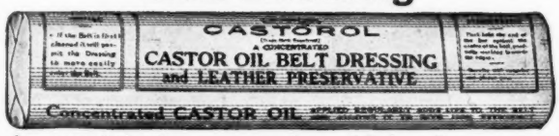

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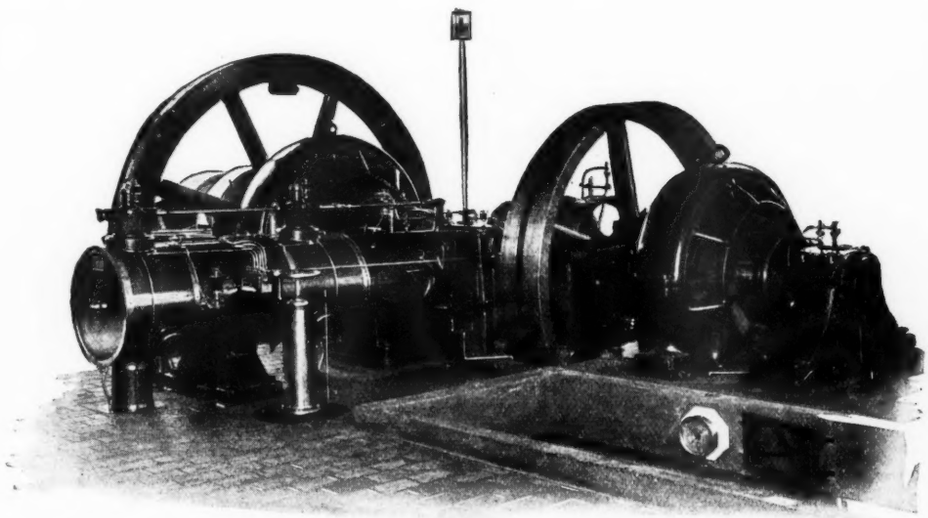

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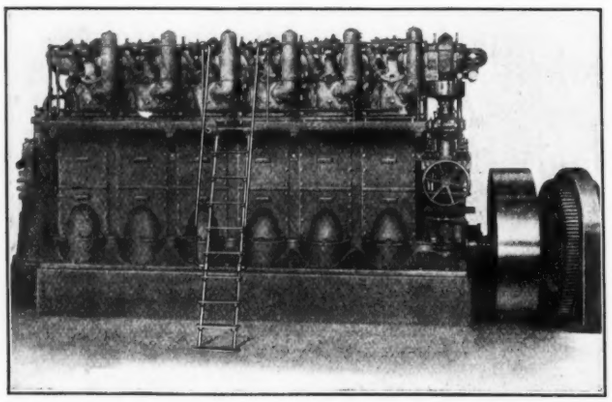

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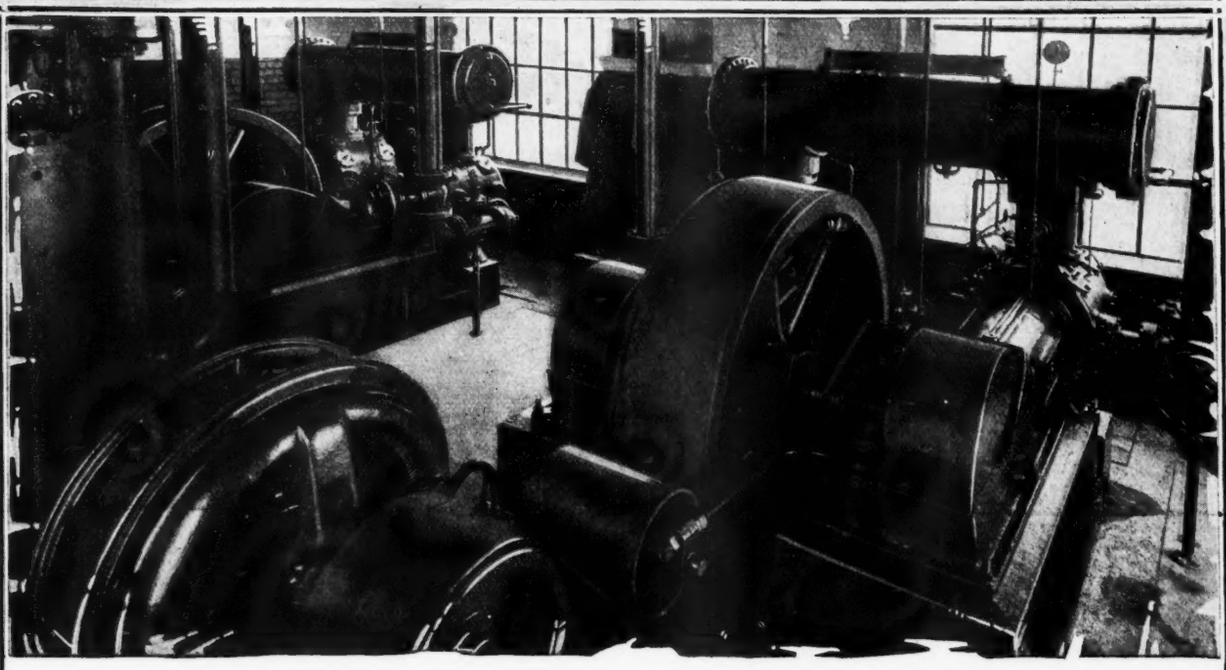

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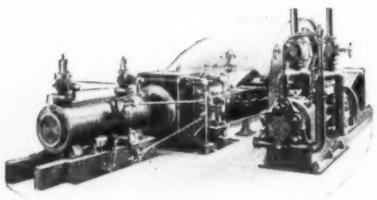

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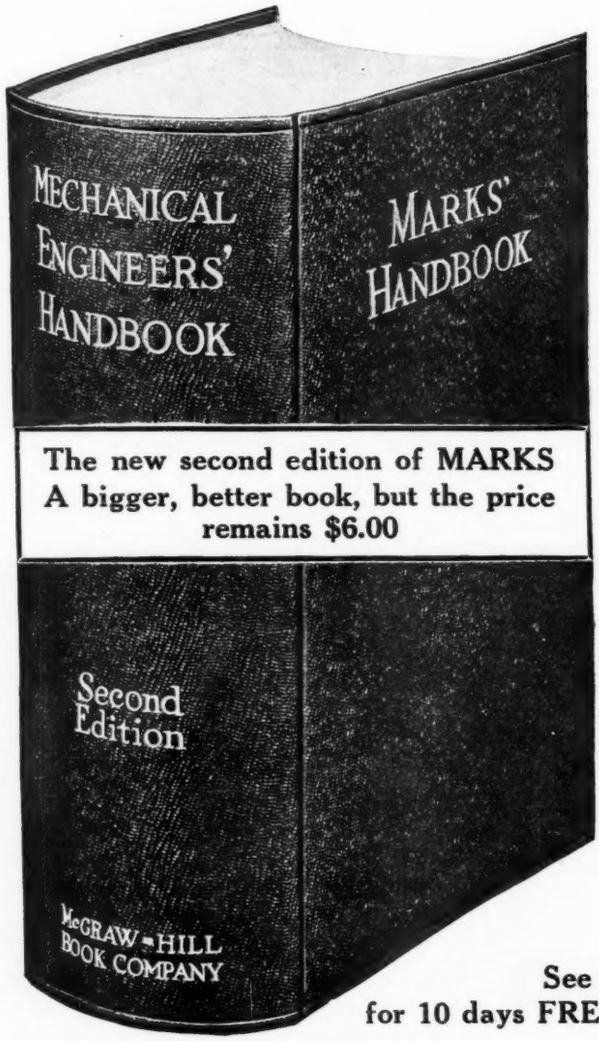

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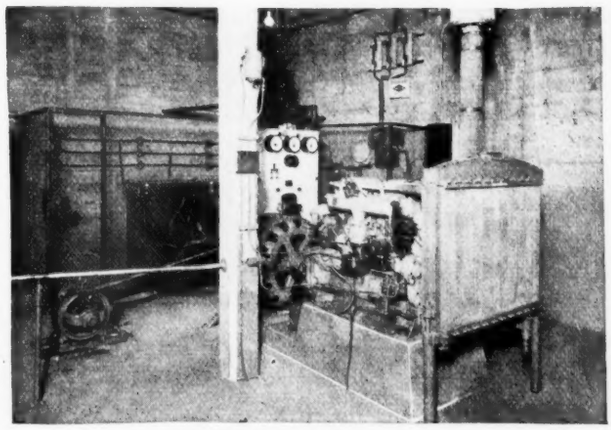

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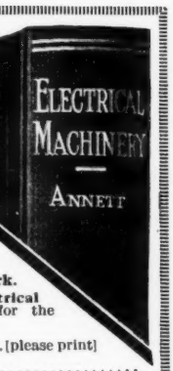

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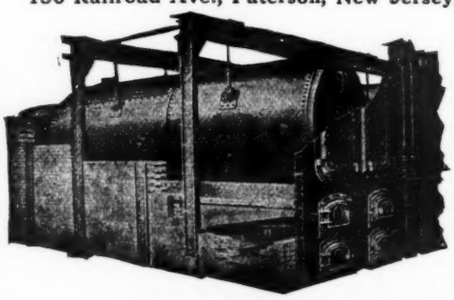

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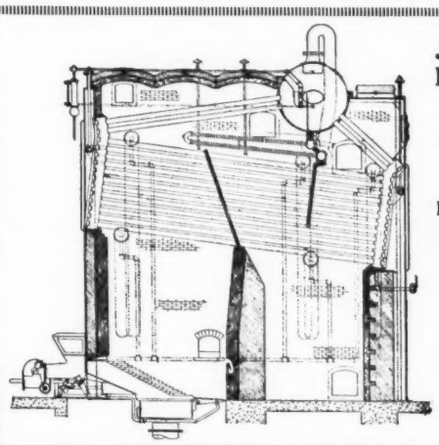

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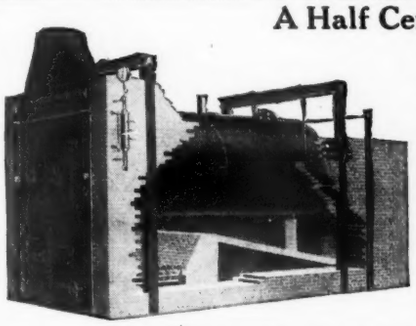

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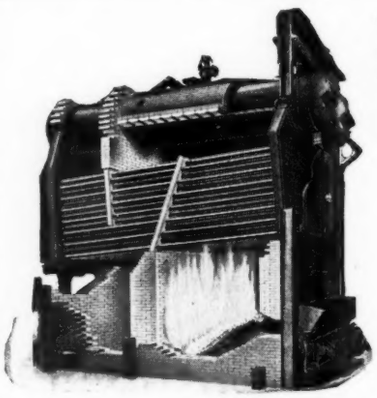

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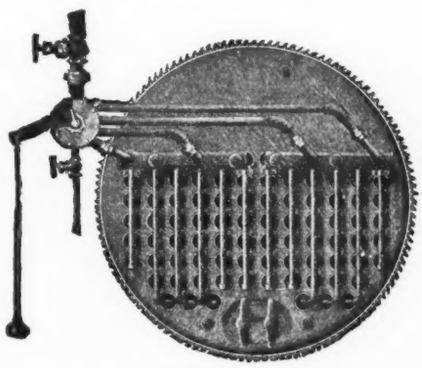

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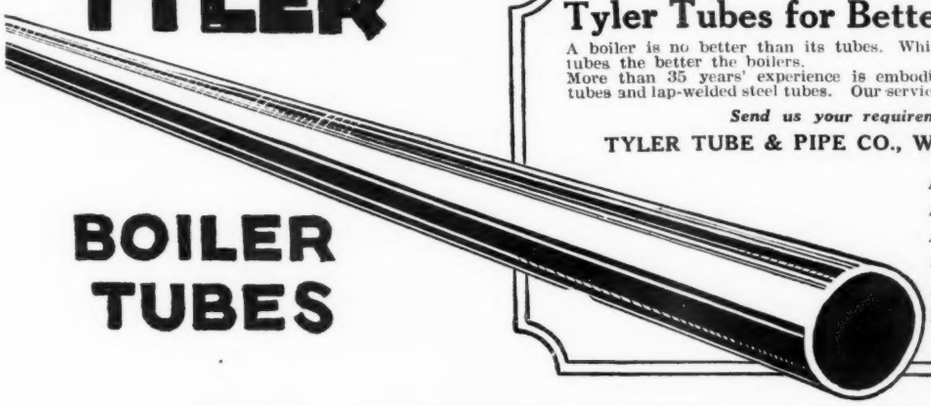

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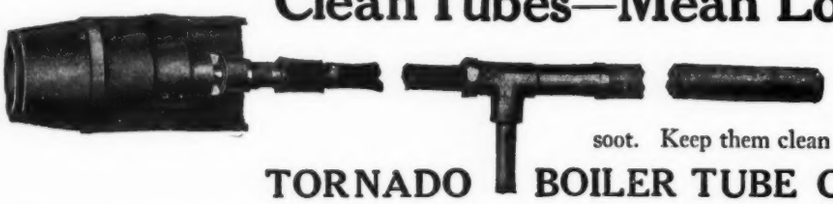

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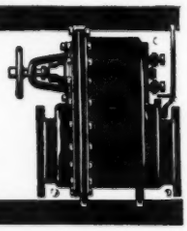

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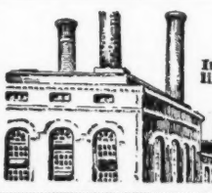

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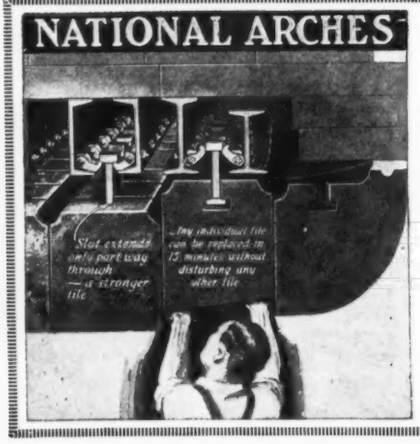
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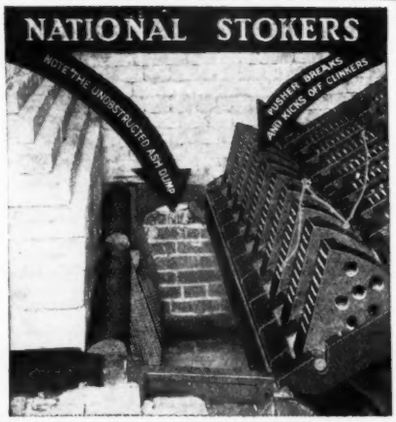

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results in permanent gradual operation to maintain the correct ratio of air to fuel in accordance with the steam demand.

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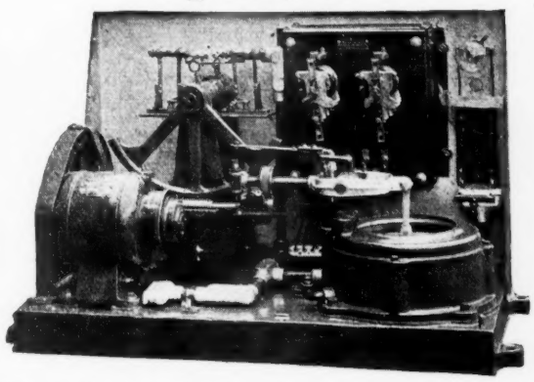

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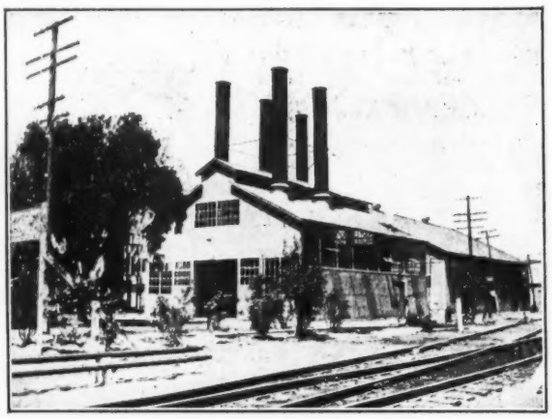

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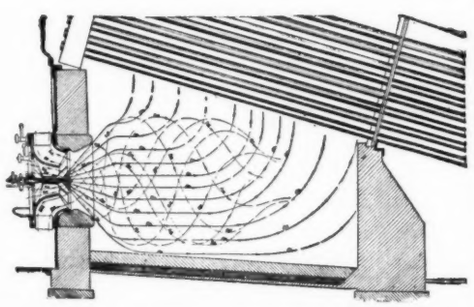

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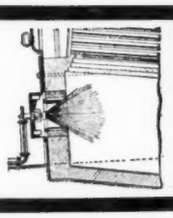

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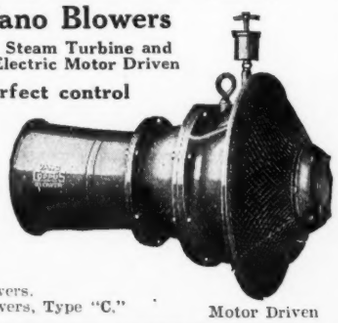

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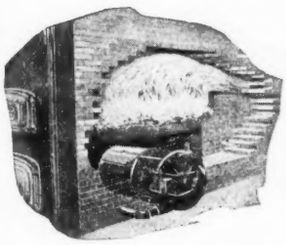

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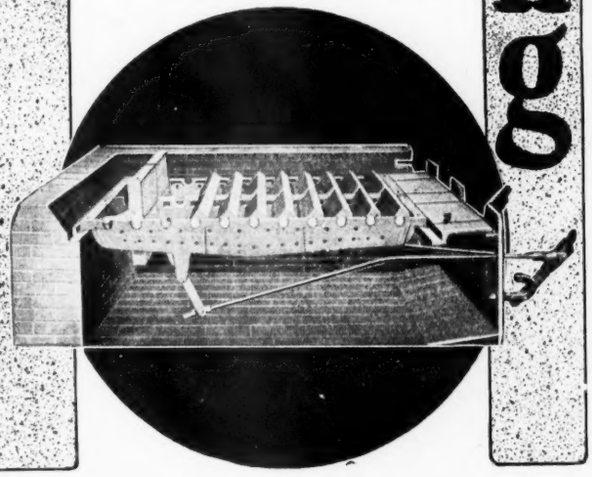

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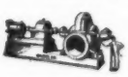

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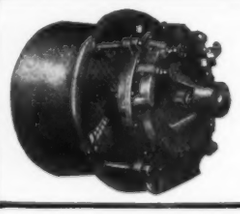

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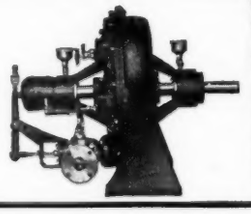

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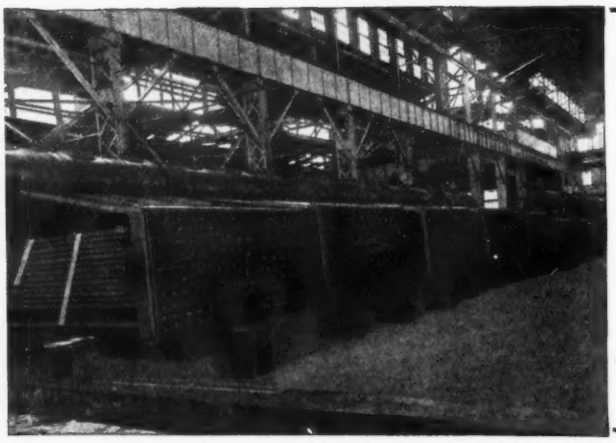

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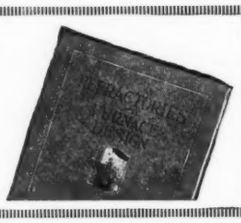

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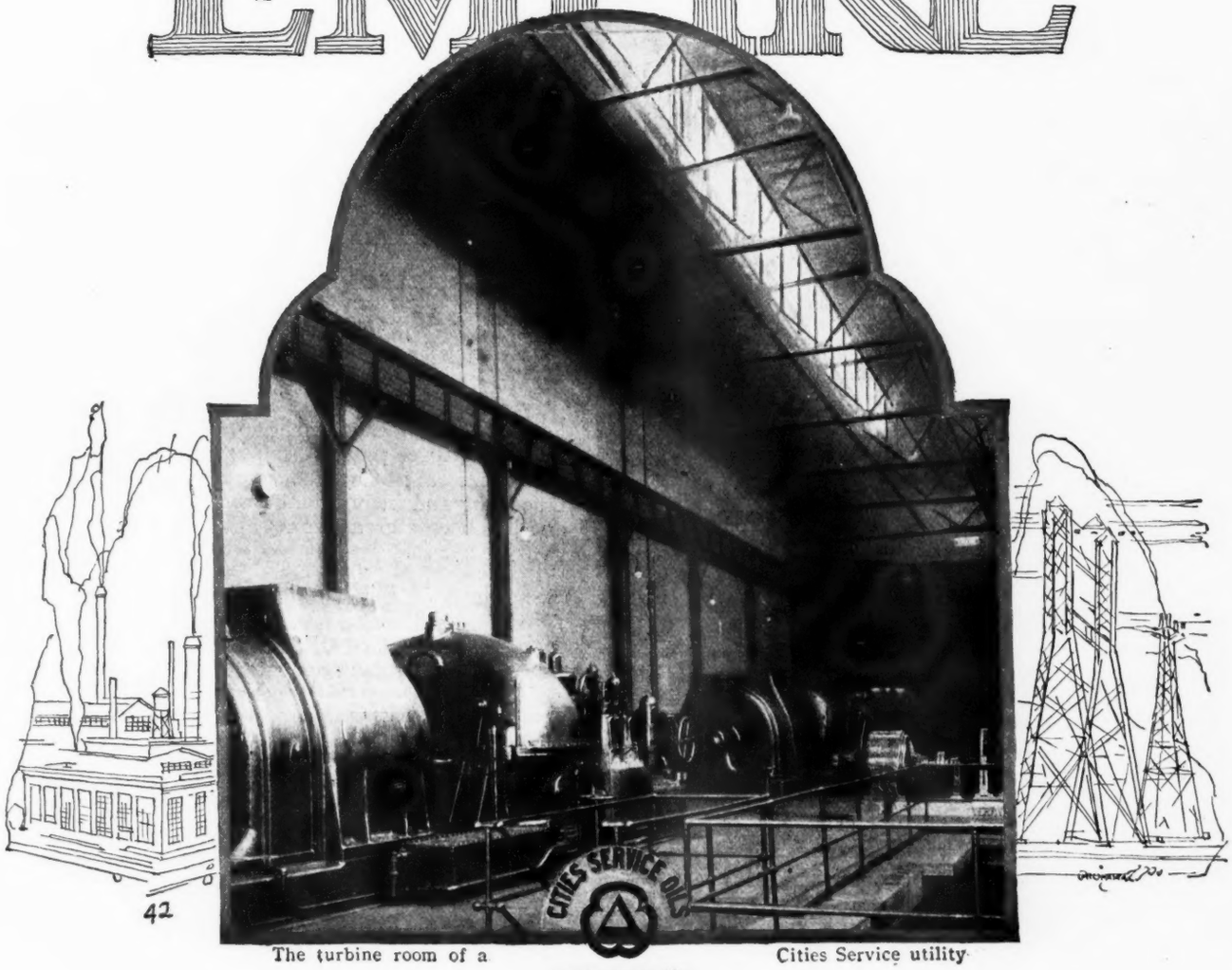

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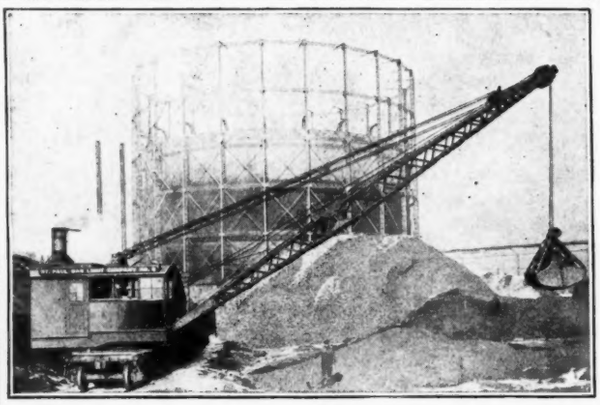

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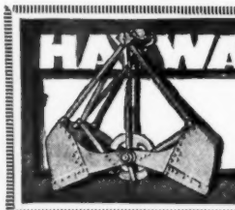

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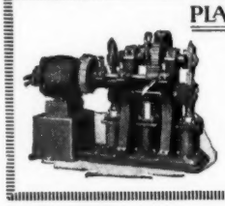

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UNITED STEAM JET CONVEYORS

The Conveyor with *Exterior Wear Sections*
For Handling Ashes, Coke Breeze, Etc.
STORAGE BINS FOR ASH AND COAL

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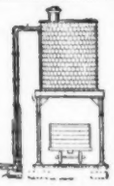

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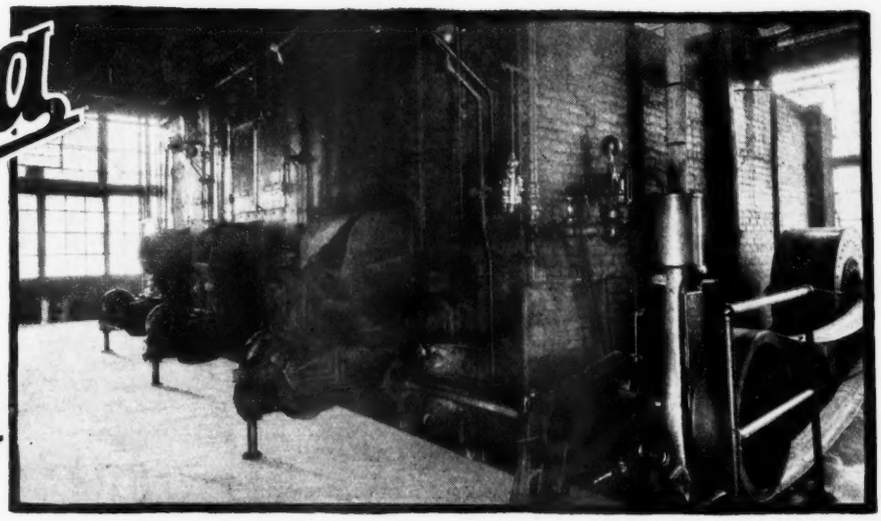

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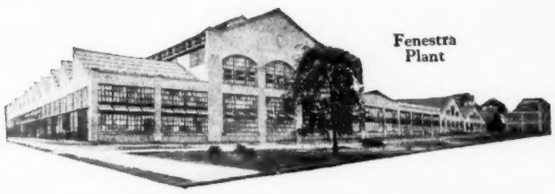
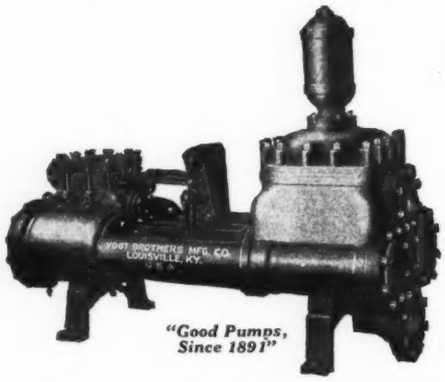


DETROIT UNDERFEED STOKERS

VOGT BROTHERS DUPLEX BOILER FEED AND GENERAL SERVICE PUMPS



"Good Pumps, Since 1891"

We are the largest builders of Pumping Machinery in the South.

Let us figure on your requirements in Single or Duplex Pumps for any service.

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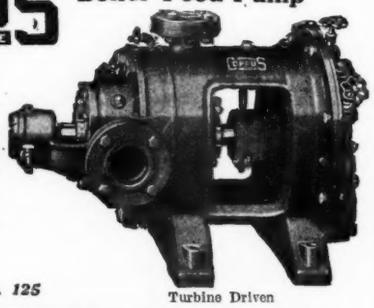
(NATIONAL FOUNDRY & MACHINE CO.)
INCORPORATED
LOUISVILLE. KENTUCKY.

THE HEART OF THE BOILER PLANT

REGISTERED COPPUS U.S. PAT. OFFICE
Boiler Feed Pump

A single unit steam turbine or electric motor driven, steady flow — no vibration — high efficiency — little attention.



Turbine Driven

Write for Bulletin No. 125

COPPUS ENGINEERING CORPORATION
350 Park Ave., Worcester, Mass.

WESTCO PUMPS
SHALLOW WELL

WESTCO:—A suction—high pressure—single stage pump. Operates against varying pressures which need not be predetermined. Made in all sizes and capacities and of materials to resist chemical action.

CHIPPEWA:—A steady stream—overlapping double stroke—deep well plunger pump of unique design and rugged construction. Made in sizes to meet any requirement.

Send today for complete data

WESTCO-CHIPPEWA PUMP CO.
620 West Front St., Davenport, Iowa

CHIPPEWA PUMPS
DEEP WELL

WARREN PUMPS
Built to the Highest Standard
by
WARREN STEAM PUMP COMPANY
Main Office and Works
Warren, Mass.

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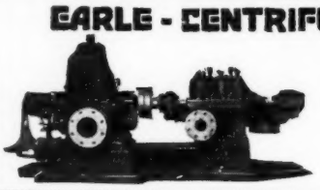
LECOURTENAY

CENTRIFUGAL PUMPS

LECOURTENAY CO.
9 MAINE STREET
NEWARK, NEW JERSEY

EARLE - CENTRIFUGAL - PUMPS



For all purposes where centrifugal pumps of the better class are adapted.

The Earle Gear & Mach. Co.
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Philadelphia, Pa.

WATER SOFTENERS
Hot—Cold—Intermittent—Zeolite
Complete Engineering Service
GRAVER *Corporation*
3100 Todd Avenue, East Chicago, Indiana

RoTURBo CENTRIFUGAL PUMPS
Manistee Iron Works Co., Manistee, Michigan

BUILT BY SPECIALISTS

We build the pump to suit your service.

Builders of Centrifugal and Rotary Pumps

TABER PUMP CO., 291 Elm St., Buffalo, N.Y.

For Efficient Pump Control

Positive regulation of discharge pressures between 10 to 150 lb. is always certain with

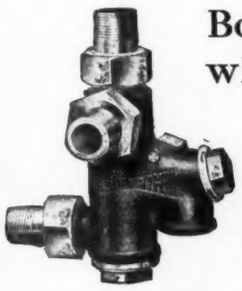
MASON Pump Regulators

Made in sizes from ½ in. to 1½ in. with bronze bodies. Sizes 2 in. to 4 in. have iron body, bronze mounted.

A quality product that is backed by the Mason experience and reputation, extending over a period of 40 years.

Write us direct for technical Catalog. Buy through your dealer.

Mason Regulator Co.
Adams and Medway Sts.
BOSTON, MASS.



Boiler feed water when you need it—

The emergency is when you need a thing most. For instance, if anything happens to your boiler feed pumps, you need a a dependable injector to keep your plant going.

You can get such service from—

PENBERTHY PRODUCTS

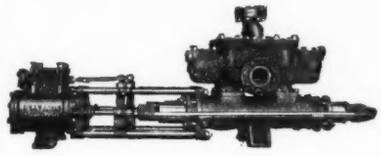
Automatic Injectors

Automatic Cellar Drainer

Our full guarantee stands behind them. Penberthys must lift the water 3-ft. with any steam pressure from 20 to 170 lb. before they are permitted to leave our factory. All tests are made under boiler room conditions.

Write for our catalog to get further details

Penberthy Injector Co.
(Established 1886)
Canadian Plant Windsor, Canada
1236 Holden Ave. Detroit, Mich.



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We have a sales correspondent in your vicinity.

We have built good pumps for 50 years.

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DEAN BROS. CO. INDIANAPOLIS.

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A TYPE FOR EVERY SERVICE

Bulletins on request.

THE GOULDS MANUFACTURING COMPANY
Seneca Falls, N. Y.
Agencies in all principal cities

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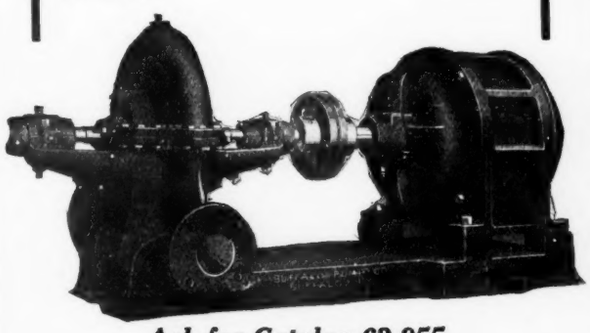
"Buffalo" Class "S" PUMPS

Low Cost—Long Life

Large production of Class "S" pumps enables us to sell them very reasonably. Their operating cost is also remarkably low because of their design, which includes renewable clearance rings, double suction impeller for hydraulic balance, divided casing for easy inspection, and many other features.



Ask for Catalog 62-955

Buffalo Steam Pump Co.
488 Broadway, Buffalo, N. Y.

One of the
NICHOLSON
Steam
Specialties

More than a steam separator—

NICHOLSON
Automatic Eliminator

Designed to install the easiest way in horizontal steam line leading to engine, pump, compressor, steam hammer or turbine, or similar equipment. This combination steam separator and trap is guaranteed to supply steam that is 99.5% dry, and to arrest the largest probable slugs of water that can come over from the boilers. Made of either cast iron or steel for all service.

Twenty-one years of reputation for full satisfactory service stand behind this Nicholson Eliminator

Write for Full Details

W. H. Nicholson & Co.
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Makers of Automatic Eliminators, Steam Separators; Piston-Operated Traps; Weight-Operated Traps; Expansion Steam Traps; Automatic Moisture Separators; Controlling Valves; Locomotive Gage Cocks; Locomotive Cylinder Cocks; Ball Gage Cocks, Gage Cocks; Roller Tube Expander; Plain Lubricators; Water Gages; Straightway Self-Cleaning Strainers; Socket Wrenches; and Pipe Flanges.

"Any Nicholson Product will be sent on approval"

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Steam Specialties

The SWARTWOUT COMPANY

General Offices: 18511 Euclid Ave., Cleveland, Ohio
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Swartwout Products: Ventilators, Metal Buildings, Industrial Ovens, Feed Water Heaters, Exhaust Heads, Traps, Steam, Air and Oil Separators.

Morehead
Back to Boiler
More Power
SYSTEM

Steam that circulates freely through dry lines delivers its utmost power. Maintain this condition with a Morehead Back-to-Boiler System that drains the lines of condensation and returns it hot to the boiler.

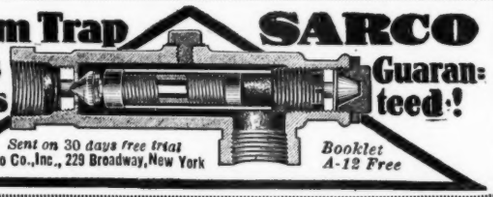
Morehead Manufacturing Company
Dept. PM., Detroit, Michigan
(87)

ARMSTRONG STEAM TRAPS

The inverted submerged principle gives:
Greater capacity than any trap of equal size. Self-scrubbing. Cannot pass steam, action quick and positive. Non air-binding. Small size. Low cost.

Armstrong Machine Works
312 Steam Savings St., Three Rivers, Mich.

Steam Trap SARCO
Costs ⅔ less
Guaranteed!



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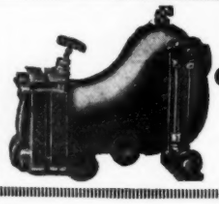
Sarco Co., Inc., 229 Broadway, New York
Booklet A-12 Free



McDaniel Improved Traps
mean
CONTINUOUS OPERATION
without Steam Leakage
Write for information
Watson & McDaniel Co.
150 N. 7th St., Philadelphia, Pa.

Steam Separators
Oil Separators
Steam Traps
Exhaust Heads
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Air Traps
Boiler Alarm Water Columns
Boiler Feed Water Regulators
Water Gauges and Gauge Cocks
Automatic Receiver Pumps
Pump Governors
Oil Traps

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WRIGHT-AUSTIN CO
Detroit, Michigan

GENUINE

Steam and Air Traps

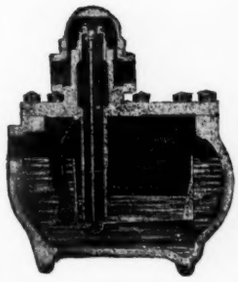
Get all the power you pay for

The Genuine Squires Steam Trap

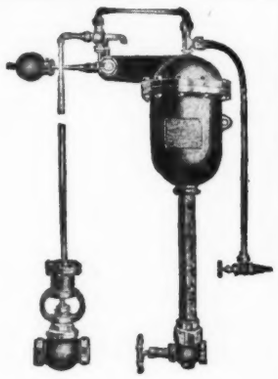
ejects condensation without steam loss. It is simple and positive in operation—soon pays for its installation cost in fuel saving.

Catalog A-9 explains its workings.

The C. E. Squires Company
East 40th St. and Kelley Ave., Cleveland, Ohio



Always on the job



VIGILANT Feed Water Regulators, by maintaining the water level at *middle gauge*, preclude the danger of boiler explosions due to low water, or cylinder flooding due to high water.

Write for further details.

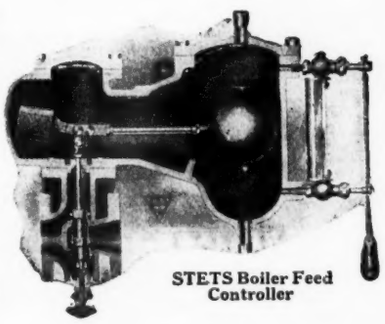
The Chaplin-Fulton Mfg. Co.
28-34 Penn Avenue
Pittsburgh, Penna.
Also Manufacturers of the Fulton Pump Governor

Double V-Port Valve

The Ideal Water Flow Control—Found Only in the

STETS Type "B" Boiler Feed Controller

This is important to remember when considering the subject of mechanical boiler feed control.



STETS Boiler Feed Controller

Because *without* the V-Port Valve there *cannot* be the sensitiveness and positiveness you want for efficient feed water control.

This valve does not seat—hence, it cannot stick, and the response is instantaneous, without the usual lag.

A phantom view of this valve is shown in a new booklet, as well as a minute description of the Type B, Stets Boiler Feed Controller.

Just ask for Booklet A-2.

The Williams Gauge Co.
743 Fourth Ave., Pittsburgh, Pa.

A New Year Is Dawning

It is the eighty-fifth for

NASON STEAM TRAPS

Nason Manufacturing Co.
71 Fulton St., New York

THE MERCON REGULATOR

MERcury CONtrol *Principle of Regulation Applied to*
Differential Type Regulator for Steam or Motor Driven Boiler Feed Pumps
Constant Flow Regulator for Individual Boiler Control
Constant Pressure Reducing Valve Back Pressure Regulator
D. H. SKEEN & COMPANY, Chicago, Ill.

Self-Grinding, 3-year Steam-Tight Valve
Constant Flow, Solid Shell, Ball Float Type
No Links, Levers, Pins or Counterweights

ALL SERVICE **PRYKO, INC.** NO REPAIRS

Agents Wanted

THE WANSTALL STEAM TRAPS

39 CORTLANDT STREET, NEW YORK

Get Bulletin No. 9254

STERLING TRAPS

Return Traps *Lifting Traps* *Vacuum Traps*
Separating Traps *Air Eliminators*

Sterling Engineering & Manufacturing Corp.
(Templeton Mfg. Co.) 119 Business St., Boston, Mass.

BUNDY STEAM TRAPS

Separating **Boiler Return**
Three Valve Pumping

BUNDY STEAM TRAP CO.
Nashua, N. H.

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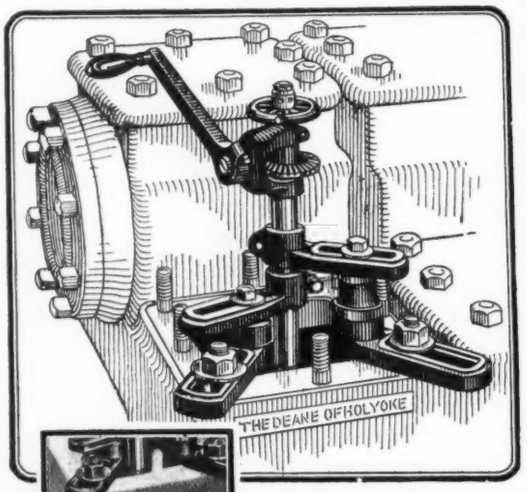
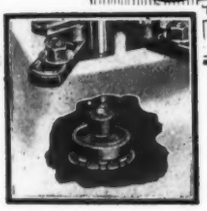
THE INSIGNIA OF SERVICE
THE EMBLEM OF QUALITY
THE
GARLOCK PACKING CO.
PALMYRA, N. Y.

The Standard Packing of the World





How to Fix Leaky Pumps

Racing, power-wasting pumps are no longer tolerated in plants striving for operating economy. It is too easy and inexpensive to keep every pump at top-notch efficiency by refacing the valve seats with a Dexter Pump Valve Reseating Machine.

The Dexter Machine is quickly bolted to the studs of the valve chamber. Cutters are automatically self-leveling. A few turns of the handle, turning feed wheel slowly, and the valve seat is perfectly true and smooth. Pump strokage is reduced 40 to 80 per cent.

Look over the pumps in your plant. Wouldn't it be worth while to keep their steam consumption at a minimum, lessen depreciation and maintain full pumping capacity? The saving will pay for a Dexter Outfit many times over.

Ask for Catalog 23 Containing Complete Information

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10 East River Street, Orange, Mass., U. S. A.
Canadian Agency:
Darling Bros., Ltd., 120 Prince St., Montreal
British Agency:
Cromil Engineering Co.,
E. Floor, Milburn House, Newcastle-on-Tyne.

7498

DEXTER
VALVE RESEATING
MACHINES

DEAN

ELECTRIC CONTROL UNIT
FOR THE MOTOR OPERATION OF LARGE
GATE AND GLOBE VALVES
WRITE FOR BULLETINS
PAYNE DEAN LIMITED
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CHICAGO NEW YORK PITTSBURGH

READING R
EXTRA HEAVY STEEL VALVES
The valves for high temperatures and severe services.
For 350 pounds working steam pressure.
READING STEEL CASTING CO
INCORPORATED
Reading Valve and Fittings Division
An Associate Company of the American Chain Company, Inc.
929 Connecticut Avenue **Bridgeport, Conn.**

Regulating Valves for Every Service
On Which Do You Want Information?
☐ Reducing Valves ☐ Float Valves
☐ Damper Regulators ☐ Swing Joint Fittings
☐ Temperature Regulators ☐ Bronze Unions
☐ Pump Governors ☐ Thermostats
☐ Balanced Valves
Atlas Valve Co., 289 South St., Newark, N. J.

EDWARD VALVES
Main Office and Works. East Chicago, Indiana.

POWELL VALVES
The Wm. Powell Co. **Cincinnati, Ohio**

Prevent Backflow
of steam from the header into a boiler in case of a tube rupture or other break. Equip all boilers with
New Bedford "Whale Brand" Reverse Current Valves
Made of either cast iron or open hearth cast steel with "Nickel Bronze" seats and discs that will not stick. Write.
New Bedford Valve Mfg. Co.,
New Bedford, Mass.

Making "Backflow" a Back Number

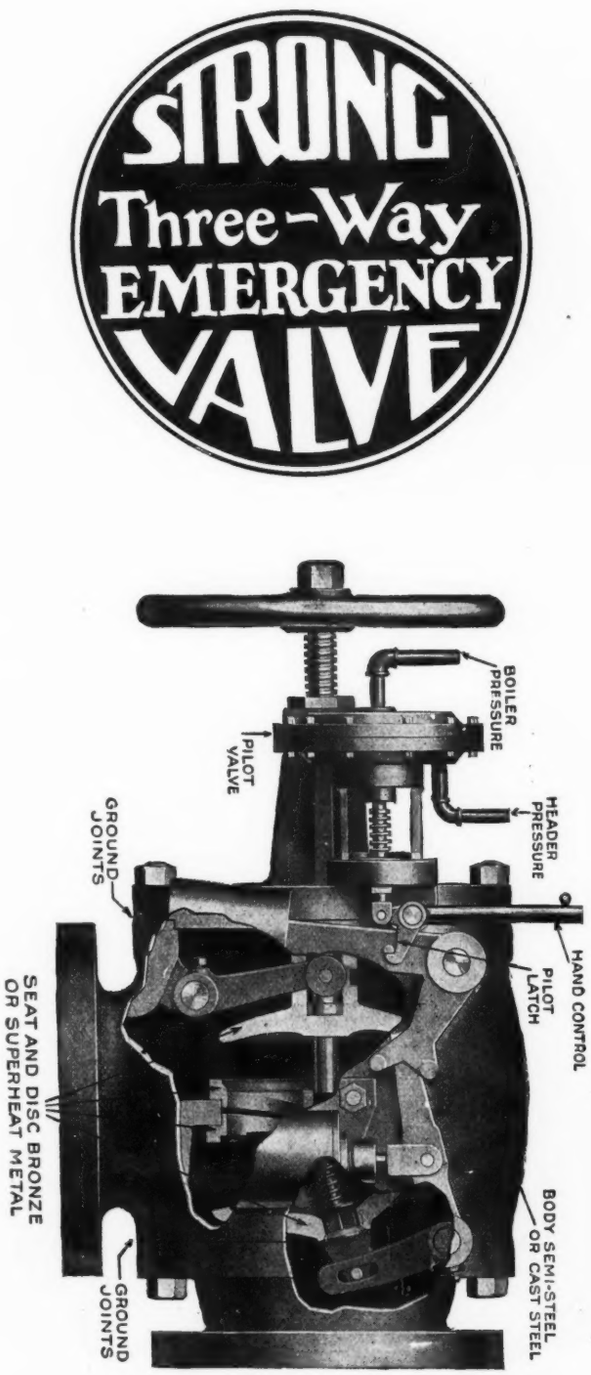
Nothing is doing more to bring that about than the STRONG Three-way Emergency Valve.

Installed in the line between the boiler and the main header, this valve affords complete protection from the dangers arising from a backflow of steam from the header as a result of a ruptured tube. It automatically allows steam to flow from the boiler into the header when the boiler pressure is equal to or greater than the header pressure, and automatically closes when the pressure in the header becomes greater than the pressure in the boiler.

It automatically equalizes the pressure between all boilers and automatically cuts a fresh boiler into the line with perfect safety.

By means of a wheel it can be shut by hand —but cannot be opened by hand.

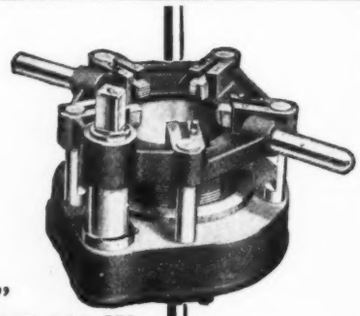
The illustration makes the principal features clear. Furnished in angle, horizontal and vertical types.



More complete information will be found in Catalog 28, sent on request.

The Strong, Carlisle & Hammond Co.

1392 West Third Street
Cleveland, Ohio



WHY LIFT EXTRA WEIGHT?

THIS "TOLEDO" NO. 2 THREADING 2½ IN. TO 4 IN. PIPE WEIGHS 56 LBS.—

—As it is picked up to be put on the pipe. It will reach piping jobs no other tool of this capacity will handle.

It is a strictly portable, easy operating threading device and will prove its worth in every power plant.

A post card will bring you the complete "Toledo" catalog.

"TOLEDO"
TRADE-MARK REGISTERED
Let This Mark *Be Your Guide*

THE TOLEDO PIPE THREADING MACHINE CO.
TOLEDO, OHIO
New York Office: 50 Church St.

They Have *Proved Satisfactory*

wherever they have been installed—and that is the principal reason for the wide distribution of

DART UNIONS

Probably it was the **Bronze to Bronze Seats** which prevent corrosion or maybe it was the leakless service which is found in Dart—at any rate they have made good in every respect.

Ask Your Dealer or Write Us Direct.

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The Fairbanks Company, Sales Agents. Canadian Factory: Dart Union Co., Ltd., Toronto.

STEERE ENGINEERING CO.
DETROIT, MICHIGAN.

Saves Labor of 2 to 6 Men—

because very little power is required to operate the

FORBES **Pipe Threading and Cutting Off Machine**

Threads any pipe or bend from ¼ to 16 in. The only machine that holds pipe stationary and revolves cutters. Portable, making it unnecessary to cart heavy pipe. Write

CURTIS & CURTIS CO.
85 Garden St., Bridgeport, Conn.

KENNEDY VALVES

FOR EVERY POWER PLANT SERVICE

Gate, globe, angle and check valve patterns; all bronze, iron body—bronze mounted, and all iron; for screwed or flanged connections, and in a wide range of sizes for low, medium, high and extra high pressures. Also complete lines of standard cast iron flanged and malleable iron screwed pipe fittings. Send for catalog.

New York, Chicago
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The Kennedy Valve Mfg. Co., Elmira, N. Y.

Salt Lake City
El Paso, Seattle

NAVCO **National** NAVCO

POWER PIPING

National Valve and Manufacturing Co.
3101 Liberty Ave. - Pittsburgh, Pa.

One-Fifth The Weight of Cast Iron Pipe

One-Third The Weight of Wrought Pipe

AN ABSOLUTELY TIGHT DURABLE PIPE

Fully 50% stronger than Straight Riveted Pipe of equal thickness. Light weight and simplicity of bolted connections results in low handling and installation expense. Extensively used in Power Plants for Atmospheric Exhaust, Cooling Pond and Forced Draft. Particularly adaptable for Suction and Discharge Water Lines, Vacuum Lines, Exhaust Steam Lines to Dryers, etc., and Large Low Pressure Air Lines.

ABENDROTH & ROOT MFG. CO.
Pipe Specialties Continuously Since 1867. Sales Office: Woolworth Bldg., N. Y.

This free sample can of

KEY GRAPHITE PASTE

Contains sufficient paste to apply it to several pipe joints, valve stems, cylinder heads, and any place where leaks are likely to occur, to prove to you that it

Seals high pressure joints leak proof!

Yet permits easy opening

Put your name here .....

Your address here .....

Clip and mail to Key Boiler Equipment Co., 27th & McCasland Ave., E. St. Louis, Ill.

P. 12-30-24

Atwood

equipment for high pressure piping systems

includes:

Motor Operated Gate Valves	Atwood Line Welds
Cylinder Operated Gate Valves	Cast-Steel Gate Valves
Steam Separators	Non-Return Valves
Interlock Welded Necks	Standard Valves for all pressures

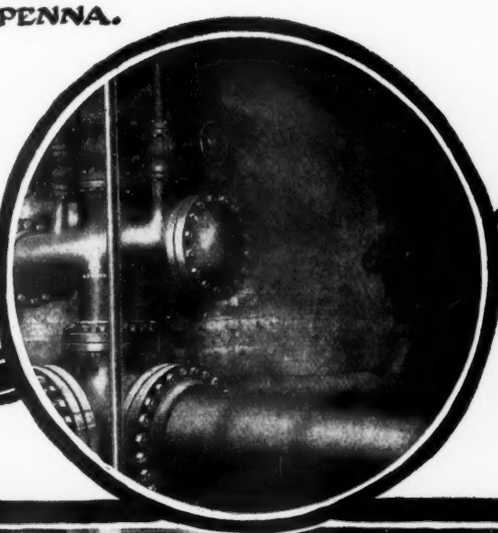
Pipe Bends, Swedges, Joints of every description, etc.

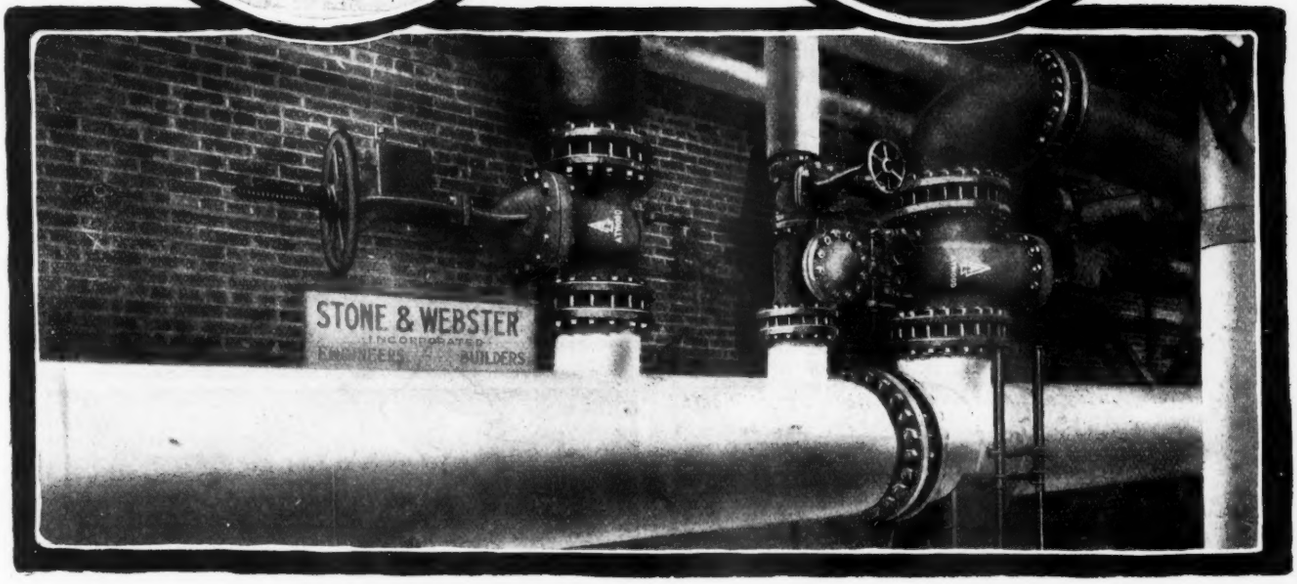
PRACTICALLY EVERYTHING required in the piping of a modern power plant is designed, manufactured and installed by this Company. Over 20 years of specialization in this field is proof of our ability to serve you properly.

PITTSBURGH VALVE, FOUNDRY & CONSTRUCTION CO.

26th St. and A. V. R.R.

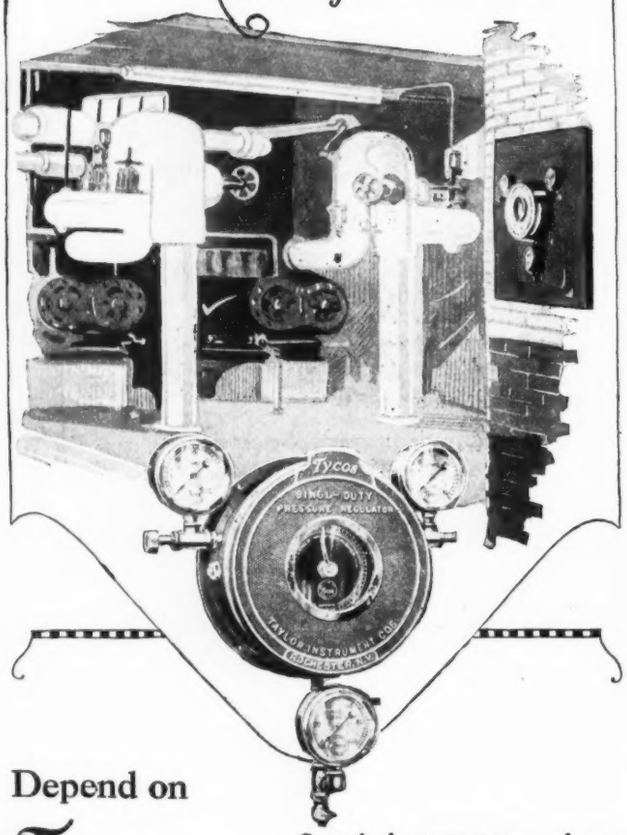
PITTSBURGH ~ PENNA.





Tycos

Recording Thermometers



Depend on *Tycos* for Constant Temperature

Control the temperature of your feed water heaters, de-superheaters and hot water service tanks with *Tycos* Temperature Regulators.

Made in three types—to meet conditions where abundant exhaust team is available for heating and where it is necessary to supplement it with live steam to make up the deficiency.

The *Tycos* Singl-Duty Temperature Regulator can be mounted on a central gage board up to 75 feet away from the heater. It is intended for use where heat is constantly supplied from one source.

The *Tycos* Type P Temperature Regulator is intended for direct attachment to the heater or tank in which the temperature is to be controlled.

The *Tycos* Dubl-Duty Temperature Regulator is especially applicable to control temperature in a de-superheater and wherever the supply of heat comes from two sources.

Our engineering department is available for recommendations regarding your temperature regulation.

Write for Catalog on Tycos Instruments for Steam Power Plants.

Taylor Instrument Companies

ROCHESTER, N. Y.

Canadian Plant, 110-112 Church St., *Tycos* Bldg., Toronto

There is a *Tycos* or *Taylor* Temperature Instrument for every purpose 440

Power Piping

FOR EVERY INDUSTRIAL NEED

Write for loose-leaf handbook containing valuable piping information.

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831 Beaver Ave., N. S.
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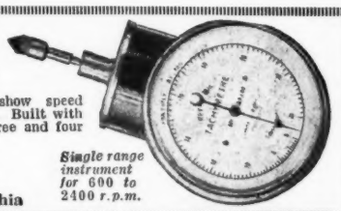
MIDWEST

FABRICATED PIPING
Ready to Erect—Including
PIPE BENDS—FLANGED PIPE—WELDED NOZZLE HEADERS
VALVES—FITTINGS—SPECIALTIES
For Any Pressure or Service

MIDWEST PIPING AND SUPPLY CO.
ST. LOUIS

"Jagabi" Type C Hand Tachometers



accurately indicate speeds and show speed variations. Large dial easily read. Built with one range (as shown) also with three and four ranges up to 24,000 r.p.m.

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Single range instrument for 600 to 2400 r.p.m.

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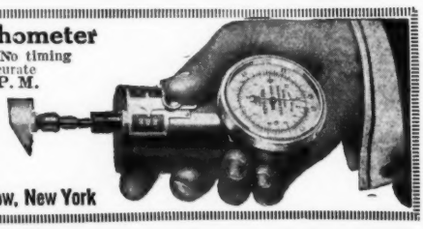

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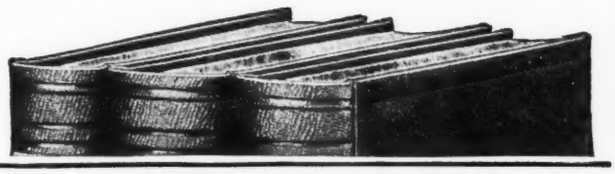

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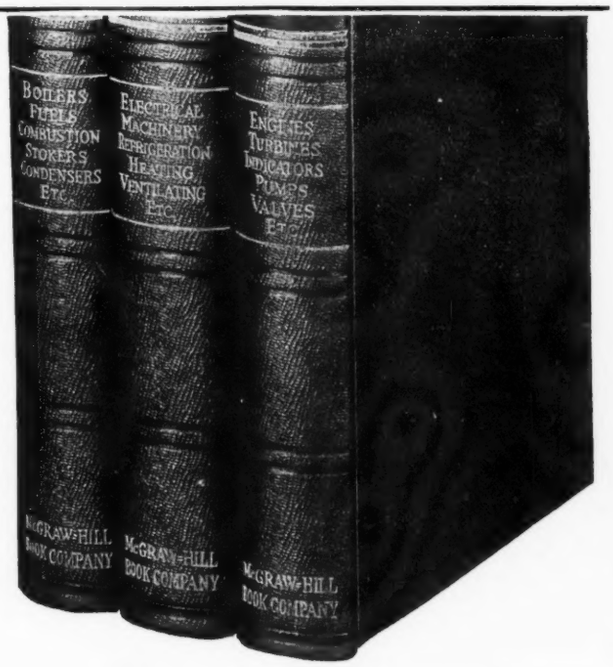

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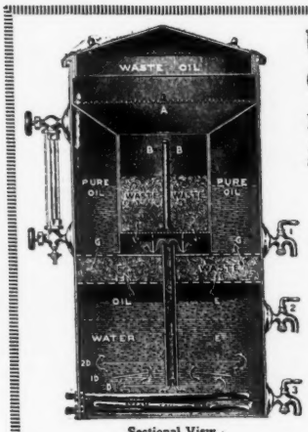

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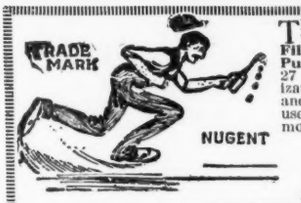

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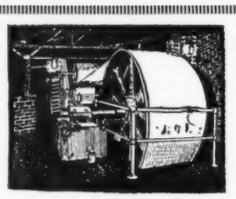

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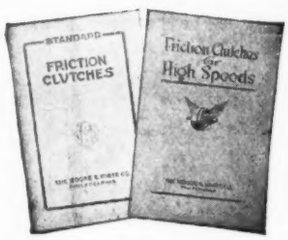

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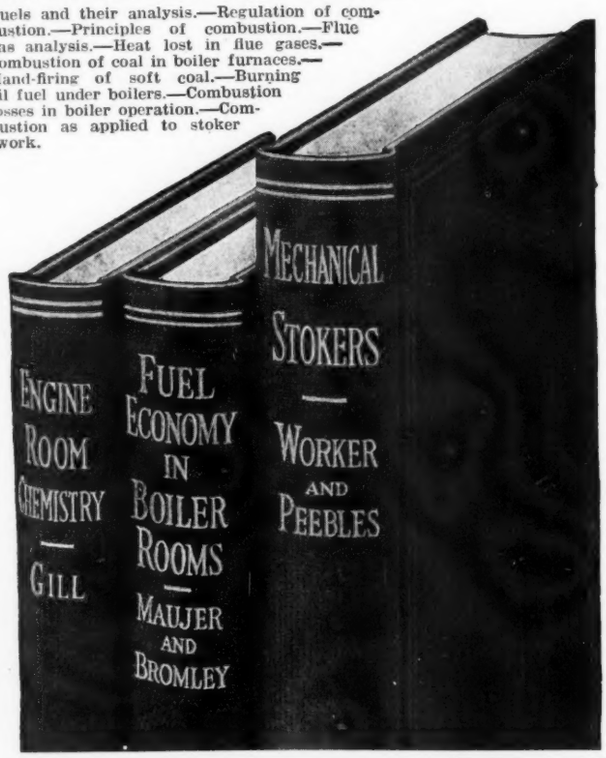

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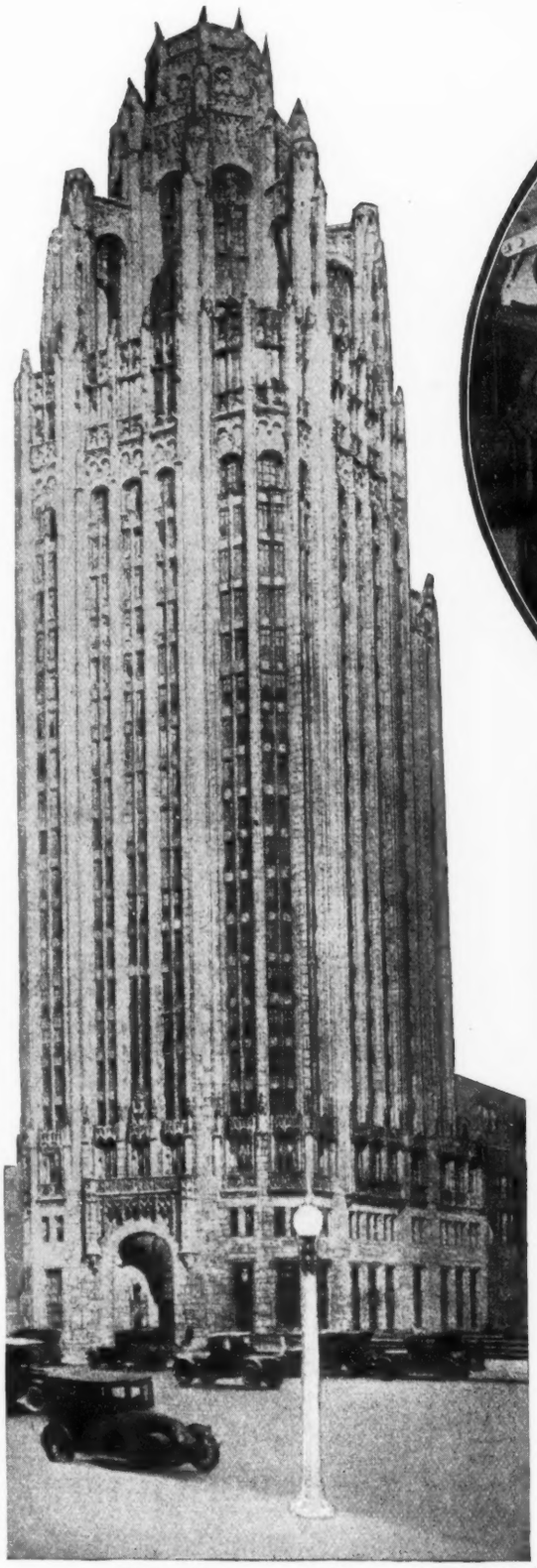

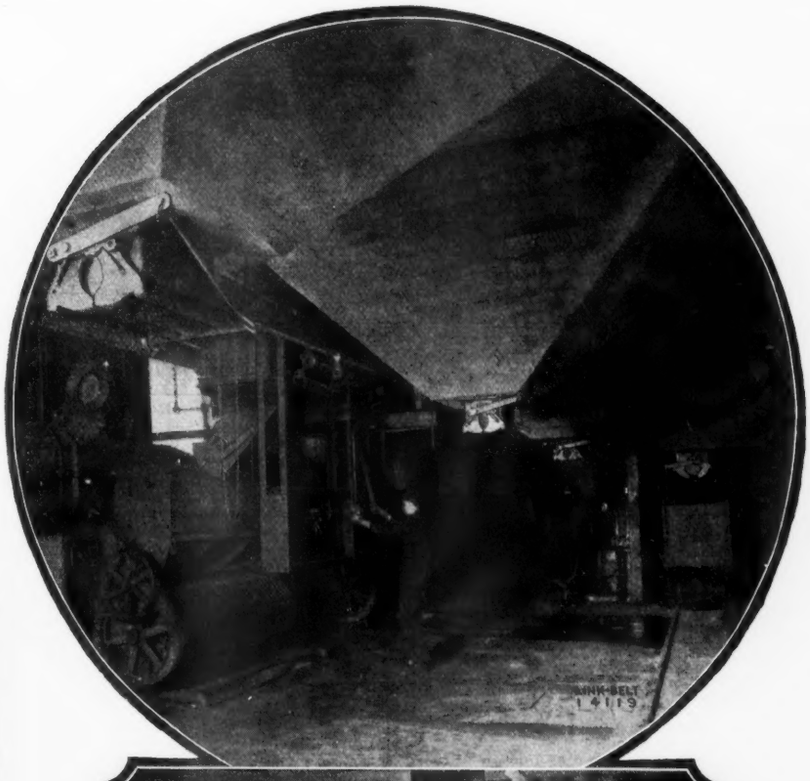

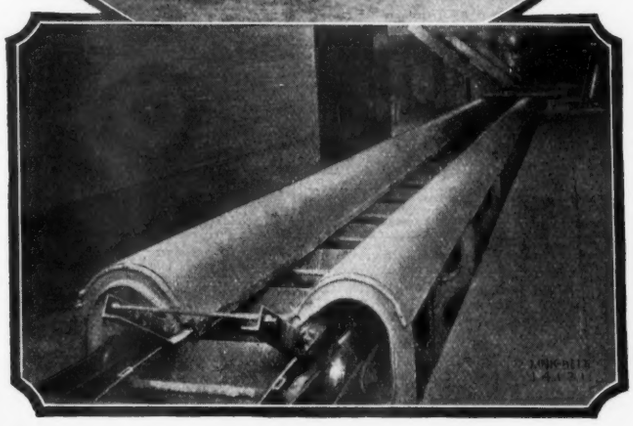

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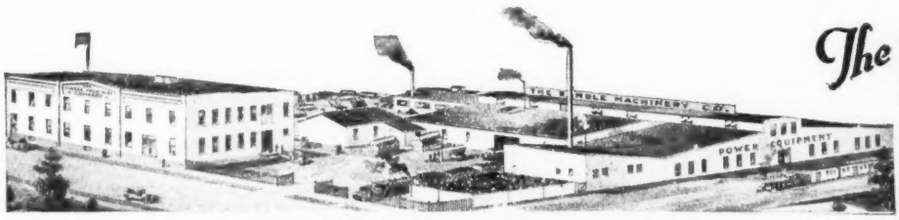

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Skinner Engine, Erie, Pa. No. 7448 Crocker-Wheeler Generator. Size 83D, Type C.C.D., 75 kw., 275 r.p.m., 125 v., 600 amp., No. 57044.
No. 2 Skinner Engine, Erie, Pa. No. 7447 Wheeler Generator. Size 53.1, Type C.C.D., 50 kw., 275 r.p.m., 125 v., 400 amp., No. 57044.

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1—Elevator Pump. Worthington Pump Co. Size 12 and 18½, 8½x10, No. 193374.

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4—Allis-Chalmers 18x36-in. Corliss Engines, heavy duty mill type. Left hand only.

Write for prices and specifications

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Old Hickory, Tennessee

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250 hp. Standard Cross Drum Watertube Built for 200 lb. Working Pressure.

PUMPS

10 x6 x10 Horizontal Duplex.
10 x6 x12 Horizontal Duplex.
6 x5¾ x 6 Horizontal Duplex.
4½x2¾x 4 Horizontal Duplex.
10 x 6 x12 Vertical Simplex.

CONDENSERS

2400—2000 and 800 square foot Cooling Surface.

HEATERS

No. 10 Reilly Type D Two Pass, complete with fittings.

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General Electric and Engberg makes, direct connected to Vertical Engines, automatic self-oiling compound wound, 110 to 125 volts, D.C. Complete with switchboard.

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2—Steam Monarch Corliss Engines with cylinders 18-in. in diameter and 36-in. stroke. Each directly connected to 200-kw. 3-wire D.C. Westinghouse generator; 100 r.p.m. with 150 pound steam pressure. Each engine is rated at 300-hp.; for further information write to

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3-Phase, 60-Cycle

Kva.	*Gen.*	*Engine*
625	Wghse.	Parsons Turbine (Bleeder)
500	Gen. Elec.	Curtis Turbine
450	Gen. Elec.	Skinner Unaflow
470	Wghse.	Parsons Turbine
360	Gen. Elec.	Harris Corliss
312	Gen. Elec.	Skinner Unaflow
250	Al.-Chal.	Al.-Chal. Corliss
250	Gen. Elec.	Skinner Unaflow
250	Gen. Elec.	Erie Ball, 4-valve
200	Al.-Chal.	Al.-Chal. Corliss
187	Gen. Elec.	Erie City, 4-valve
150	Al.-Chal.	Al.-Chal. Corliss
125	Gen. Elec.	Harrisburg, 4-valve
125	Gen. Elec.	Erie City, 4-valve
125	Gen. Elec.	Erie Ball, 4-valve
100	Gen. Elec.	Skinner

Kva.	*Gen.*	*Engine*
90	Gen. Elec.	Skinner Unaflow
90	Gen. Elec.	Ames Unaflow
75	Gen. Elec.	Skinner
70	Wghse.	Harrisburg
50	Gen. Elec.	Skinner

A. C. Generators

Kva.	*Make*	*Speed*
1000 (4)	Gen. Elec.	180
560	Gen. Elec. (3 Brg.)	300
500	Gen. Elec. (3 Brg.)	360
412	Al.-Chal. (3 Brg.)	450
400	Gen. Elec. (3 Brg.)	360
360	Wghse. (3 Brg.)	360
300	Gen. Elec. (3 Brg.)	450
300	Al.-Chal. (3 Brg.)	600
300	Gen. Elec.	720

Kva.	*Make*	*Speed*
250	Wghse.	600
225	Gen. Elec.	600
200	Wghse.	450
200	Gen. Elec.	600
187	Al.-Chal.	600
160	Gen. Elec.	164
150	Al.-Chal.	900
150	Wghse.	450
125	Al.-Chal.	900
125	Gen. Elec.	600
100	Al.-Chal.	900
75	Gen. Elec.	1200
56	Gen. Elec.	1200

DIRECT CURRENT UNITS

Generator	*Engine*	*Price*
250-kw. Burke, 125-volt	Skinner Uniflow	$4500
250-kw. Wghse., 250-volt	Erie Ball	3000
150-kw. C-W., 125-volt	Erie City, 4-valve	2000
115-kw. C-W., 125-volt	Erie City, 4-valve	1750

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150-kw., 125/250-volts, 220-r.p.m., 600-ampere Westinghouse Generator-direct connected to a 16x26x16 Harrisburg-Fleming tandem compound engine.

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150-kw., 220/440-volts, 2 or 3-phase, 60-cycle, 200-r.p.m. Westinghouse Generator, with exciter, direct connected to a Russell non-condensing, 4-valve horizontal tandem compound engine.

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Cleveland, Ohio

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3 PHASE, 60 CYCLES

Qu.	*Hp.*	*Make*	*Volts*	*Type*	*Speed*
1	500	Crocker-Wheeler, synchronous	440	.....	1200
1	300	Allis-Chalmers, synchronous	440	.....	600
1	300	General Electric, slip ring	440	PT140	450
1	250	General Electric, synchronous	2300	ATB	600
1	225	General Electric, slip ring	440	IM	514
1	200	Westinghouse, 3 bearing	2200	CCL	600
1	200	Western Electric, slip ring	440/220	IM	600
2	170	General Electric, synchronous	2300	ATI	514
1	150	Westinghouse	220	CS	1200
1	150	Lincoln to a 1500 G.P.M., 240 ft. head centrifugal pump	440	IP	1800
1	150	General Electric, slip ring	440	M	600
1	150	General Electric	2200/440	L	600
2	104	General Electric, slip ring	220	.....	865
1	100	Westinghouse	220/440	CCL	575
1	100	Westinghouse, slip ring	220/440	CW	680
1	100	Westinghouse, unused, slip ring	220	MW342	1160
1	100	Allis-Chalmers	440	AN	690
1	75	Westinghouse, slip ring	2200	HF	600
1	75	Westinghouse	220	CCL	850
1	75	General Electric, unused	440	KT	720
2	75	General Electric	440	ITC5013A	600
2	75	Allis-Chalmers	440	AN	865

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1—200 hp. G.E. Slip Ring Motor, 600 r.p.m.
1—150 hp. G.E. Squirrel Cage Motor, 850 r.p.m.
1—150 hp. G.E. Wound Rotor Motor, 600 r.p.m.
2—150 hp. G.E. Slip Ring Motors, 600 r.p.m.
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INDEPENDENT
Electric Machinery Co.
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USED MOTORS

3 Phase, 60 Cycle Motors

Quan.	*Hp.*	*Type*	*Volt*	*Speed*	*Make*
1	¼	B.S.T.	440	1800	G.E.
1	½	KT112	440	1200	G.E.
5	½	B	440	1200	F.M.
29	7½	CS170931-A	440	1200	West.
37	7½	13D	440	1200	A.C.
1	7½	3K	440	1200	A.C.
2c	7½	1 Form	440	900	G.E.
5c	10	.....	440	900	G.E.
1	10	17G	440	1200	A.C.
2	10	17C	440	1200	A.C.
8	15	17K	440	1200	A.C.
2	15	17D	440	1200	A.C.
3c	15	.....	440	720	G.E.
1c	15	1 Form	440	900	G.E.
1	30	20G	440	1800	A.C.
2	30	CS	440	1200	West.
6	30	KT332	440	1200	G.E.
4cx	40	MT336Y	440	1200	G.E.
2cx	40	.....	440	1200	West.
2	75	CS160874A	440	1800	West.
5	75	.....	440	720	G.E.
1	150	CS179274B	2200	1800	West.

Single Phase, 60 Cycle Motors

1	10	RI-627	220/110	1800	G.E.

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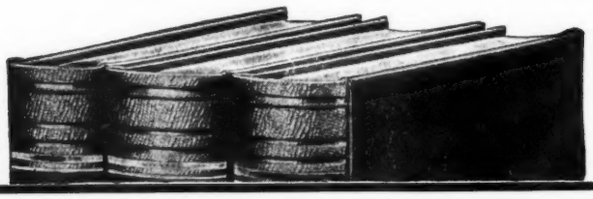

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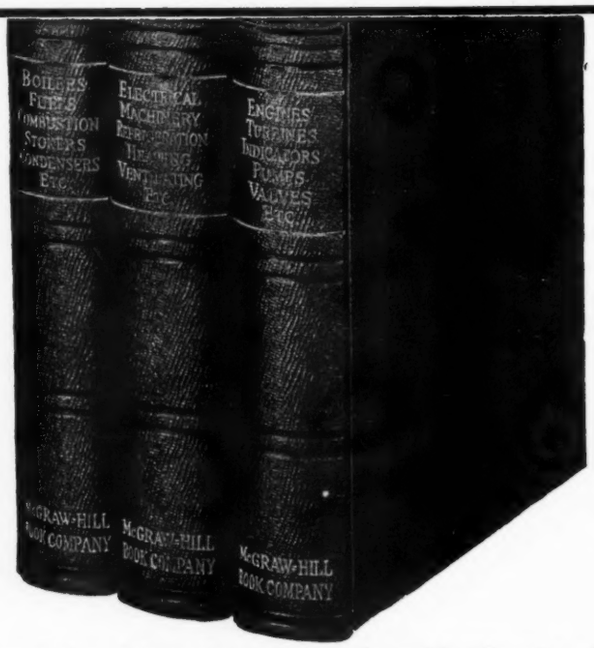

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THE ONLY PEOPLE WHO DO NOT GET RIDGWAY ELEVATORS IF THEY HAVE STEAM ARE THOSE WHO DO NOT KNOW IT.

So we are printing these half page cards every week in order that you may know this WONDER ELEVATOR.

In order to indicate the machine is worth looking into, we print below a sample of the 3000 users.

We give ABSOLUTE PERFECTION IN ELEVATOR SERVICE and NOBODY PAYS ONE CENT UNTIL WE MAKE GOOD.

United Gas Improvement Co.	H. J. Heinz Co. "57"	United States Government
Yale & Towne Mfg. Co.	International Harvester Co.	E. I. Du Pont & Co.
Cluett Peabody & Co.	John Wanamaker	General Electric Co.
Consolidated Gas Co.	Remington Typewriter Co.	Packard Motor Car Co.
Nat'l Cash Register Co.	Continental Gin Co.	Continental Can Co.
Hammermill Paper Co.	Erie Railroad Co.	American Tobacco Co.
Procter & Gamble Co.	Crane & Co. (Dalton)	John Morrell & Co.

The Ridgway Elevator is the one machine in a plant that always goes so long as the boiler holds together.

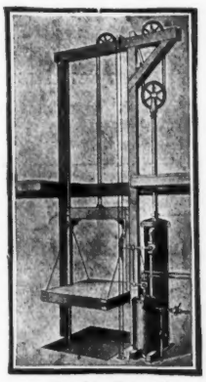
No matter how neglected or abused it never fails to function and function PERFECTLY.

These are some reasons why THE BIG FELLERS like those up there

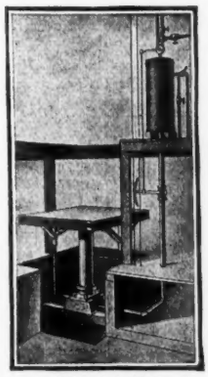
"HOOK 'ER TO THE BILER"

Craig Ridgway & Fils Co.

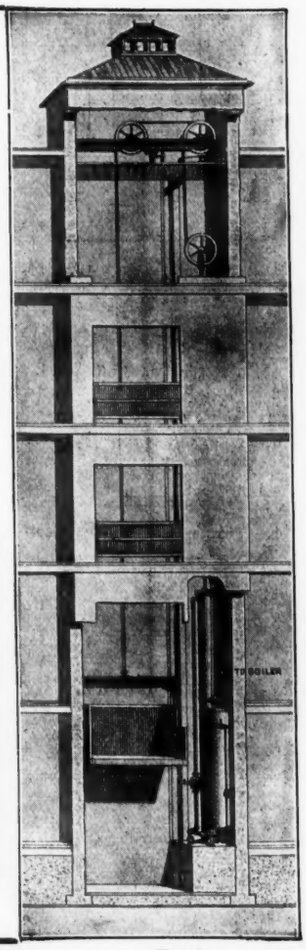
Over 3000 in daily use **COATESVILLE, PA.**



Double Geared



Direct Acting

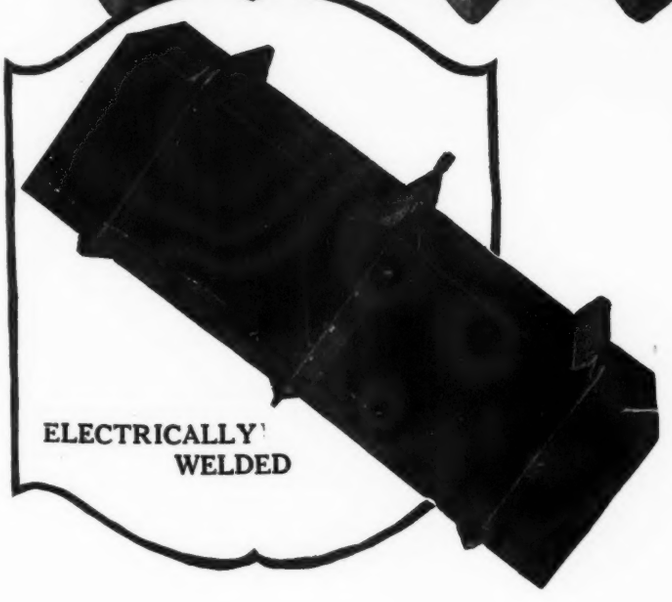


CONNERY'S IMPROVED

Accordion Type

EXPANSION STIFFENED

for breeching—smoke flues—air ducts



the bellows principle for flexibility—

The sensible way—the obvious way, to build smoke flues, boiler breeching, air ducts.

This construction eliminates buckling, warping or collapsing. Provides the maximum contraction and expansion. Completely eliminates the use of sliding joints. Electrically welded throughout at all corners and laps, assuring positive air-tight, moisture-proof construction. No internal corrosion is possible.

Costs no more than the old type of construction

CONNERY & COMPANY, INC.

Philadelphia, Pa. **New York, N. Y.**

WHAT AND WHERE TO BUY

Equipment, Apparatus and Supplies Used in the Power Plant Field with Names and Addresses of Manufacturers and Distributors

See Last Page for Alphabetical Index

Aftercoolers and Receivers, Air
Chicago Pneumatic Tool Co., N. Y.
Nordberg Mfg. Co., Milwaukee

Air Chambers
Hercules Float Works, Springfield, Mass.

Air Conditioning
Buffalo Forge Co., Buffalo, N. Y.

Alternators
Allis-Chalmers Mfg. Co., Milwaukee

Alternators, Turbo
Allis-Chalmers Mfg. Co., Milwaukee
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Ridgway (Pa.) Dynamo & Engine Co.
Terry Steam Turbine Co., Hartford

Arches, Flat
Hofft Co., M. A., Indianapolis
Laclede-Christy, St. Louis
Liptak Fire Brick Arch. Co., Chicago

Arches, Suspended
Bigelow Arch Co., Detroit
Brady Conveyors Corp., Chicago
Detrick Co., M. H., Chicago
Hofft Co., M. A., Indianapolis
Illinois Stoker Co., 104 W. 7th St., Alton, Ill.
Jointless Fire Brick Co., 1144 Clay St., Chicago
Liptak Fire Brick Arch. Co., Chicago
McLeod & Henry Co., Troy, N. Y.

Ardometers
Bacharach Ind. Inst. Co., 7008 Bennett St., Pittsburgh

Asbestos Lumber
Johns-Manville, Inc., N. Y.

Asbestos Products
Carey Co., Philip, Lockland, Cinn.

Ashgates and Hoppers for Pulverized Fuel
Allen, Sherman, Hoff Co., Phila.
Baker, Dunbar Co., Cleveland

Ash Handling Equipment
Allen, Sherman, Hoff Co., Phila.
Baker, Dunbar Co., Cleveland
Brady Conveyors Corp., Chicago
Combustion Engrg. Corp., N. Y.
Conveyors Corp. of Amer., Chicago
Detrick Co., M. H., Chicago
Gifford Wood Co., Hudson, N. Y.
Girtanner Engr. Co., N. Y.
Link-Belt Co., Chicago
McMyler Interstate Co., Cleveland
United Conveyors Corp., Chicago

Ash Quenchers
Allen, Sherman, Hoff Co., Phila.

Ash Sluicing Systems
Allen, Sherman, Hoff Co., Phila.

Ash Tanks, Cast Iron
Baker, Dunbar Co., Cleveland
Conveyors Corp. of Amer., Chicago

Ash Tanks, Tile
United Conveyors Corp., Chicago

Baffle Walls
Engineer Co., N. Y.
Harbison-Walker Refractories Co., Pittsburgh
Johns-Manville, Inc., N. Y.
Liptak Fire Brick Arch Co., Chicago
McLeod & Henry Co., Troy, N. Y.

Baffles, Boiler
Betson Plastic Fire Brick Co., Rome, N. Y.
Engineer Co., N. Y.
King Refractories Co., Buffalo
Laclede-Christy, St. Louis

Baffles, Monolithic
Betson Plastic Fire Brick Co., Rome, N. Y.
King Refractories Co., Buffalo

Bearings
Magnolia Metal Co., N. Y.

Belting
Garlock Packing Co., Palmyra, N.Y.
Greene, Tweed & Co., N. Y.
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
Rhoads & Sons, J. E., Phila.

Belting Conveyor
N. Y. Belting & Packing Co., N. Y.

Belting Leather (Waterproof)
Rhoads & Son, J. E., Phila.

Belting, Rubber
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
United States Rubber Co., N. Y.

Bins
Blaw-Knox Co., Pittsburgh
Brown Hoist. Machy. Co., Cleveland

Blowers, Centrifugal
Buffalo Forge Co., Buffalo, N. Y.
Carling Turbine Blower Co., 104 Harding St., Worcester, Mass.
Coppus Eng. Corp., Worcester, Mass.
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Green Fuel Economizer Co., Beacon, N. Y.
Wing Mfg. Co., L. J., N. Y.

Blowers, Fan
American Blower Co., Detroit
Carling Turbine Blower Co., 104 Harding St., Worcester, Mass.
Clarage Fan Co., Kalamazoo, Mich.
Coppus Eng. Corp., Worcester, Mass.
Engineer Co., N. Y.
General Electric Co., Schenectady
Green Fuel Economizer Co., Beacon, N. Y.
Power Turbo-Blower Co., N. Y.
Wing Mfg. Co., L. J., N. Y.

Blowers, Forced Draft
American Blower Co., Detroit
Carling Turbine Blower Co., 104 Harding St., Worcester, Mass.
Clarage Fan Co., Kalamazoo, Mich.
Coppus Eng. Corp., Worcester, Mass.
Howden & Co. of America, James, N. Y.
McClave-Brooks Co., Scranton, Pa.
Wing Mfg Co., L. J., N. Y.

Blowers, Induced Draft
Clarage Fan Co., Kalamazoo, Mich.
Coppus Eng. Corp., Worcester, Mass.
Prat-Daniel Corp., N. Y.

Blowers, Soot
Huyette Co., Paul B., Phila.
Marion Machine Foundry & Supply Co., Marion, Ind.
National Flue Cleaner Co., Groveville, N. J.
Vulcan Soot Cleaner Co., Webster Bldg., Du Bois, Pa.

Blowers, Steam Jet
Chesterton Co., A. W., Boston
Schutte & Koerting, Phila.

Blowers, Turbine
Carling Turbine Blower Co., 104 Harding St., Worcester, Mass.
Coppus Eng. Corp., Worcester, Mass.
Elliott Co., Wellsville, ... Y.
Moore Steam Turbine Corp., Wellsville, N. Y.
Power Turbo-Blower Co., N. Y.
Terry Steam Turbine Co., Hartford
Wing Mfg. Co., L. J., N. Y.

Boiler Fronts
McClave-Brooks Co., Scranton, Pa.

Boiler Insulation
Carey Co., Philip, Lockland, Cinn.
Celite Products Co., Chicago
Johns-Manville, Inc., N. Y.

Boiler Setting
Ballard, Sprague & Co., N. Y.
Betson Plastic Fire Brick Co., Rome, N. Y.
Cement Gun Co., Allentown, Pa.
CoKal Stoker Corp., Chicago
Detrick Co., M. H., Chicago
Illinois Stoker Co., Alton, Ill.
Jointless Fire Brick Co., 1144 Clay St., Chicago
Laclede-Christy, St. Louis
Liptak Fire Brick Arch Co., Chicago
McLeod & Henry Co., Troy, N. Y.
Naismith & Son, Geo., Pittsburgh

Boiler Tube Cleaners
(See Tube Cleaners, Boiler)
(See Blowers, Soot)

Boilers, Cross Drum
Babcock & Wilcox Co., N. Y.
Edge Moor Iron Co., Edge Moor, Del.
Wickes Boiler Co., Saginaw, Mich.
Walsh & Weidner Boiler Co., Chattanooga

Boilers, Heating
Oil City Boiler Works, Oil City, Pa.

Boilers, Portable
Erie City Iron Works, Erie, Pa.
Page Water Tube Boiler Co., Chicago

Boilers, Return Tubular
Bigelow Co., New Haven, Conn.
Coatesville (Pa.) Boiler Wks.
CoKal Stoker Corp., Chicago
Connery & Co., Philadelphia
Delany & Co., P., Newburgh, N. Y.
Erie City Iron Works, Erie, Pa.
Freeman Mfg. Co., Racine, Wis.
Keeler Co., E. Williamsport, Pa.
O'Brien Boiler Wks. Co., J., St. Louis
Smith & Sons Co., S., Paterson, N. J.
Springfield (Ill.) Boiler Co.
Union Iron Works, Erie, Pa.
Vogt Machine Co., Henry, Louisville, Ky.
Walsh & Weidner Boiler Co., Chattanooga, Tenn.

Boilers, Vertical Water Tube
Babcock & Wilcox Co., N. Y.
Bigelow Co., New Haven, Conn.
Casey-Hedges Co., Chattan'ga, Tenn.
Erie City Iron Wks., Erie, Pa.
O'Brien Boiler Wks. Co., J., St. Louis
Wickes Boiler Co., Saginaw, Mich.

Boilers, Waste Heat
Edge Moor (Del.) Iron Co.

Boilers, Water Tube
Babcock & Wilcox Co., N. Y.
Badenhausen, Phillips, Phila.
Bethlehem (Pa.) Shipbuilding Corp.
Bigelow Co., New Haven, Conn.
Casey-Hedges Co., Chattan'ga, Tenn.
Connelly Boiler Co., D., Cleveland
Edge Moor (Del.) Iron Co.
Erie City Iron Works, Erie, Pa.
Freeman Mfg. Co., Racine, Wis.
Keeler Co., E. Williamsport, Pa.
Kidwell Boiler Co., Milwaukee
Ladd Co., Geo. T., Pittsburgh
O'Brien Boiler Wks. Co., J., St. Louis
Oil City Boiler Works, Oil City, Pa.
Page Water Tube Boiler Co., Chicago
Springfield (Ill.) Boiler Co.
Union Iron Works, Erie, Pa.
Vogt Mach. Co., Hy., Louisville, Ky.
Walsh & Weidner Boiler Co., Chattanooga, Tenn.
Wickes Boiler Co., Saginaw, Mich.

Books
McGraw-Hill Book Co., N. Y.

Breechings
Connery & Co., Philadelphia
Kidwell Boiler Co., Milwaukee
Littleford Bros., Cincinnati
Smith & Sons Co., S., Paterson, N. J.

Brick, Fire
Ashland Fire Brick Co., Ashland, Ky.
Betson Plastic Fire Brick Co., Rome, N. Y.
General Refractories Co., Phila.
Harbison-Walker Refractories Co., Pittsburgh
King Refractories Co., Buffalo
Laclede-Christy, St. Louis
Lavino & Co., E. J., Phila.
McLeod & Henry Co., Troy, N. Y.

Brick, Insulating
Celite Products Co., Chicago

Bucket Carrier, Pivoted
Gifford Wood Co., Hudson, N. Y.
Link-Belt Co., Chicago

Buckets, Clam Shell
American Hoist & Derrick Co., St. Paul, Minn.
Blaw-Knox Co., Pittsburgh
Brown Hoist. Machy. Co., Cleveland
Hayward Co., N. Y.
Industrial Works, Bay City, Mich.
Link-Belt Co., Chicago
McMyler-Interstate Co., Cleveland

Buckets, Orange-Peel
Hayward Co., N. Y.
Industrial Works, Bay City, Mich.
McMyler Interstate Co., Cleveland

Bunkers, Coal
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Brown Hoist. Machy. Co., Cleveland
Conveyors, Corp of America, Chicago
Link-Belt Co., Chicago

Burners, Gas
Tate-Jones Co., Pittsburgh, Pa.

Burners, Oil
Bethlehem (Pa.) Shipbuilding Corp.
Coen Co., San Francisco
Combustion Eng. Corp., N. Y.
Morse Dry Dock & Repair Co., Brooklyn, N. Y.
National Airoil Burner Co., Phila.
Peabody Engineering Corp., N. Y.
Tate-Jones Co., Pittsburgh, Pa.

Bushings
Magnolia Metal Co., N. Y.

Caps, Hand Hole
Key Boiler Equipment Co., E. St. Louis, Ill.

Car Pullers, Elec. Capstan and Hand
Gifford-Wood Co., Hudson, N. Y.

Castings, Brass and Iron
Bethlehem (Pa.) Shipbuilding Corp.
Neemes Foundry, Inc., Troy, N. Y.

Castings, Grey Iron
Erie City Iron Works, Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Harrisburg (Pa.) Foundry & Mach. Works
Hooven, Owens, Rentschler Co., Hamilton, Ohio
Riley Stoker Corp., Worcester

Cement, Asbestos
Carey Co., Philip, Lockland, Cinn.

Cement, Fire Brick
Betson Plastic Fire Brick Co., Rome, N. Y.
Celite Products Co., Chicago
General Refractories Co., Phila.
Johns-Manville, Inc., N. Y.
Jointless Fire Brick Co., 1144 Clay St., Chicago
King Refractories Co., Buffalo
Laclede-Christy, St. Louis
Lavino & Co., E. J., Phila.
McLeod & Henry Co., Troy, N. Y.

Cement Guns
Cement Gun Co., Allentown, Pa.

Cement, Iron
Smooth-On Mfg. Co., Jersey City, N.J.

Cement, Pipe Joint
Johns-Manville, Inc., N. Y.
Key Boiler Equipment Co., E. St. Louis, Ill.
Smooth-On Mfg. Co., Jersey City, N.J.

Chain Drive
Morse Chain Co., Ithaca, N. Y.

Chimneys (See Stacks)

Clamps, Hose
Strong Carlisle & Hammond, Cleveland

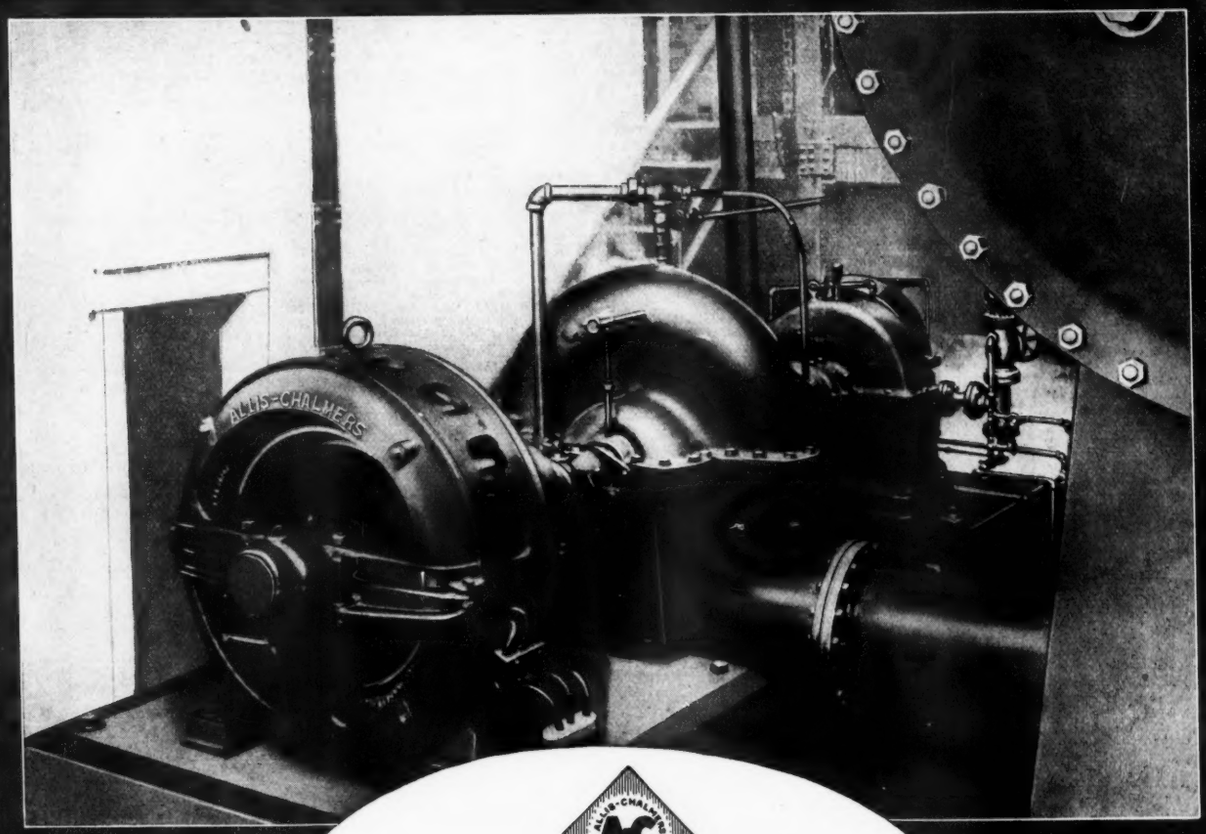
Clamps, Pipe
Yarnall-Waring Co., Mermaid Ave., Phila.

Clutches, Friction
Allis-Chalmers Mfg. Co., Milwaukee
Link-Belt Co., Chicago
Moore & White Co., Phila.

Coal Bunker Lining
Wailes Dove-Hermiston Corp., N. Y.

Coal Crushers
Beaumont Co., R. H., Phila.
Brown Hoist. Machy. Co., Cleveland
Fuller-Lehigh Co., Fullerton, Pa.
Gifford-Wood Co., Hudson, N. Y.
Link-Belt Co., Chicago

Coal Handling Equipment
American Hoist & Derrick Co., St. Paul, Minn.
Beaumont Co., R. H., Phila.
Blaw-Knox Co., Pittsburgh



AT THE HEART OF THE POWER HOUSE

Where necessity demands the most reliable equipment you will find Allis-Chalmers Centrifugal Pumping units at work every day delivering an unfailing supply of water to condensers — boilers—spray systems—general supply tanks—fire protection mains.

The careful test and inspection of Allis-Chalmers pumps before shipment guarantees that each unit will work satisfactorily under the definite conditions for which it was sold.

If you are a user of Centrifugal Pumping equipment it will pay you to investigate the "Allis-Chalmers Combined Units of Undivided Responsibility"—*Bulletin* 1632-*G sent on request.*

ALLIS-CHALMERS

MILWAUKEE, WIS. U. S. A.

Brown Hoist. Machy. Co., Cleveland
Gifford-Wood Co., Hudson, N. Y.
Girtanner Engr. Co., N. Y.
Hayward Co., N. Y.
Hunt Co., C. W., West Brighton, N. Y.
Link-Belt Co., Chicago
McMyler Interstate Co., Cleveland

Cocks, Gage
Huyette Co., Paul B., Phila.
Jenkins Bros., N. Y.
Nason Mfg. Co., N. Y.

Cocks, Steam
Dart Mfg. Co., E. M., Providence
Lunkenheimer Co., Cincinnati

Combustion Chamber, Back Arch
Betson Plastic Fire Brick Co., Rome, N. Y.
Detrick Co., M. H., Chicago
Jointless Fire Brick Co., 1144 Clay St., Chicago
McLeod & Henry Co., Troy, N. Y.

Combustion Control System
Canady Eng. Co., N. Y.
Carrick Engr. Co., Chicago
Northwestern Mfg. Co., Milwaukee
Smoot Engr. Corp., N. Y.

Combustion Controller
Canady Eng. Co., N. Y.
Carrick Engr. Co., Chicago

CO_2 Recorders and Flue Gas Analysis Instruments
Brown Instrument Co., Phila.
Huyette Co., Paul B., Phila.
Republic Flow Meters Co., 2222 Diversey Parkway, Chicago

Compressors, Air
Allis-Chalmers Mfg. Co., Milwaukee
Chicago Pneumatic Tool Co., N. Y.
General Electric Co., Schenectady
Hooven, Owens, Rentschler Co., Hamilton, Ohio
Nordberg Mfg. Co., Milwaukee
Sullivan Machinery Co., Chicago

Compressors, Extraction
Sullivan Machinery Co., Chicago

Compressors, Gasoline
Sullivan Machinery Co., Chicago

Condensers
Allis-Chalmers Mfg. Co., Milwaukee
Bethlehem (Pa.) Shipbuilding Corp.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.
Nordberg Mfg. Co., Milwaukee
Ross Heater & Mfg. Co., Buffalo
Schutte & Koerting, Philadelphia
Westinghouse E. & M. Co., East Pittsburgh
Wheeler Mfg. Co., C. H., Phila.
Wheeler Cond'r & Eng. Co., Carteret, N. J.

Condensers, Barometric & Combined
Buffalo Steam Pump Co., Buffalo
Elliott Co., Jeannette, Pa.
Wheeler Mfg. Co., C. H., Phila.

Condensers, Distilling
Bethlehem (Pa.) Shipbuilding Corp.
Buffalo Steam Pump Co., Buffalo

Condensers, Jet
Buffalo Steam Pump Co., Buffalo
Elliott Co., Jeannette, Pa.
Nordberg Mfg. Co., Milwaukee
Wheeler Mfg. Co., C. H., Phila.

Condensers, Surface
Elliott Co., Jeannette, Pa.
Wheeler Mfg. Co., C. H., Phila.

Conduits, Underground
Johns-Manville, Inc., N. Y.

Controllers, Draft
Carrick Engr. Co., Chicago
Engineer Co., N. Y.

Controllers, Electric
General Electric Co., Schenectady
Westinghouse Elec. & Mfg. Co., East Pittsburgh

Converters, Synchronous
Allis-Chalmers Mfg. Co., Milwaukee

Conveyors, Belt
Beaumont Co., R. H., Phila.
Brown Hoist. Mach. Co., Cleveland
Gifford Wood Co., Hudson, N. Y.
Link-Belt Co., Chicago

Conveyors, Portable
Gifford Wood Co., Hudson, N. Y.
Link-Belt Co., Chicago

Coolers
Griscom-Russell Co., N. Y.
Ross Heater & Mfg. Co., Buffalo
Vogt Mach. Co., Henry, Louisville

Coolers, Generator
American Blower Co., Detroit
Buffalo Forge Co., Buffalo
Ridgway (Pa.) Dynamo & Engine Co.

Coolers, Oil
Griscom-Russell Co., N. Y.

Cooling Plants and Ponds
Binks Spray Equip. Co., Chicago
Buffalo Forge Co., Buffalo, N. Y.
Yarnall-Waring Co., Mermaid Ave., Phila.

Cooling Towers
Wheeler Condenser & Engineering Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.
Wiederholdt Constr. Co., St. Louis

Couplings, Flexible Shaft
Allis-Chalmers Mfg. Co., Milwaukee
De Laval Steam Turbine Co., Trenton, N. J.
Dexter Co., I. H., Goshen, N. Y.
Foote Bros. Gear & Mach. Co., Chicago

Couplings, Shaft
Dexter Co., I. H., Goshen, N. Y.
Foote Bros. Gear & Mach. Co., Chicago
Nicholson Co., W. H., Wilkes-Barre, Pa.

Covering, Boiler
Betson Plastic Fire Brick Co., Rome, N. Y.
Celite Products Co., Chicago

Covering, Pipe
Carey Co., Philip, Lockland, Cinn.
Celite Products Co., Chicago

Cranes
American Hoist & Derrick Co., St. Paul
Brown Hoist. Mach. Co., Cleveland

Cranes, Crawler Type
Link-Belt Co., Chicago
McMyler Interstate Co., Cleveland

Cranes, Locomotive
American Hoist & Derrick Co., St. Paul
Brown Hoist. Mach. Co., Cleveland
Industrial Works, Bay City, Mich.
Link-Belt Co., Chicago
McMyler-Interstate Co., Cleveland

Cutouts, Electric
General Electric Co., Schenectady

Cutters, Boiler Tube
(See Pipe Cutters)

Cylinder Boring Bars and Reboring
Hooven, Owens, Rentschler Co., Hamilton, Ohio
Underwood Corp., H. B., Phila.

Dampers
Clarage Fan Co., Kalamazoo, Mich.

Deaerator
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Ross Heater & Mfg. Co., Buffalo

Dealers Machinery
Fuerst Friedman Co.
Hamilton, John D.
Independent Electric Mchy. Co.
Kehoe, Robt. P.
Nashville Industrial Corp.
O'Brien Mchy. Co.
Phoenix Utility Co.
Power Mchy. Exchange
Randle Mchy. Co.
Ross Power Equipment Co.
Sachsenmaier, Geo.
Scheinert Co., R.
Western Marine & Salvage Co.

Die Stocks
Curtis & Curtis Co., Bridgeport, Conn.
Greenfield (Mass.) Tap & Die Corp.
Toledo Pipe Threading Machine Co., Toledo, Ohio

Distilling Plants (Water)
Bethlehem (Pa.) Shipbuilding Corp.
Griscom-Russell Co., N. Y.
Sugar Apparatus Mfg. Co., Phila.

Doors-Ashpit
Brady Conveyors Corp., Chicago

Draft, Mechanical
(See Blowers, Fan)

Drainers, Low Pressure
Cochrane Corp., Phila.

Dressing, Belt
Cling-Surface Co., Buffalo
Keystone Lubricating Co., Phila.
Rhoads & Sons, J. E., Phila.

Dressing, Rope
Cling-Surface Co., Buffalo

Drills
Chicago Pneumatic Tool Co., N. Y.
Ingersoll-Rand Co., N. Y.

Drop Forgings
Vogt Machine Co., H., Louisville

Dynamometers
Wheeler Mfg. Co., C. H., Phila.

Dynamos (See Generators)

Economizers
Green Fuel Economizer Co., Beacon, N. Y.
Power Specialty Co., N. Y.

Ejectors
Chaplin-Fulton Mfg. Co., Pittsburgh
Penberthy Injector Co., Detroit
Schutte & Koerting, Phila.

Ejectors, Air
Elliott Company, Jeannette, Pa.

Ejectors, Sewerage
Blackburn-Smith Corp., N. Y.

Electric Controllers
Westinghouse E. & M. Co., E. Pittsburgh

Electric Generating Sets, Steam Turbine
Allis-Chalmers Mfg. Co., Milwaukee
Carling Turbine Blower Co., Worcester, Mass.
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Moore Steam Turbine Co., Wellsville, N. Y.
Ridgway (Pa.) Dynamo & Engine Co.
Terry Steam Turbine Co., Hartford, Conn.

Electric Generators
Westinghouse E. & M. Co., E. Pittsburgh

Elevators and Conveyors
Beaumont Co., R. H., Phila.
Brown Hoist. Mach. Co., Cleveland
Gifford-Wood Co., Hudson, N. Y.
Link-Belt Co., Chicago

Elevators, Factory
Ridgway & Fils Co., Craig, Coatesville, Pa.

Enamel
Wailes Dove-Hermiston Corp., N. Y.

Engineering Service
(See Directory)

Engine Repairs
Hooven, Owens, Rentschler Co., Hamilton, Ohio
Underwood Corp., H. B., Phila.

Engines, Corliss
Chuse Engine & Mfg. Co., Mattoon, Ill.
Hooven, Owens, Rentschler Co., Hamilton, Ohio
Nordberg Mfg. Co., Milwaukee

Engines, Diesel
American-Krupp System Diesel Engine Co., N. Y.
Busch-Sulzer Bros. Diesel Eng. Co., St. Louis
Lombard Governor Co., Ashland, Mass.
Nordberg Mfg. Co., Milwaukee

Engines, Gas and Oil
Busch-Sulzer Bros. Diesel Eng. Co., St. Louis
Chicago Pneumatic Tool Co., N. Y.
Hooven, Owens, Rentschler Co., Hamilton, Ohio
Sterling Engine Co., Buffalo

Engines, Hoisting
Hooven, Owens, Rentschler Co., Hamilton, Ohio

Engines, Pumping
Hooven, Owens, Renschler Co., Hamilton, Ohio

Engines, Steam
American Blower Co., Detroit
Chicago Pneumatic Tool Co., N. Y.
Chuse Engine & Mfg. Co., Mattoon, Ill.
Clarage Fan Co., Kalamazoo, Mich.
Erie City Iron Wks., Erie, Pa.
Harrisburg (Pa.) Fdy. & Mch. Wks.
Hooven, Owens, Rentschler Co., Hamilton, Ohio
Howden & Co. of America, James, N. Y.
Nordberg Mfg. Co., Milwaukee
Oil City Boiler Wks., Oil City, Pa.
Ridgway (Pa.) Dynamo & Engine Co.
Troy Eng. & Mach Co., Troy, Pa.
Vilter Mfg. Co., Milwaukee

Engines, Una-Flow
Chuse Eng. & Mfg. Co., Mattoon, Ill.
Harrisburg (Pa.) Fdy. & Mch. Wks.
Kingsford Fdy. & Mach. Co., Oswego, N. Y.
Nordberg Mfg. Co., Milwaukee

Evaporators
Bethlehem (Pa.) Shipbuilding Corp.
Griscom-Russell Co., N. Y.
Ross Heater & Mfg. Co., Buffalo
Sugar Apparatus Mfg. Co., Phila.
Wheeler Cond. & Eng. Co., Carteret, N. J.

Exhaust Heads
Burt Mfg. Co., Akron, Ohio
Fulton Fdry. & Mach. Co., Cleveland
Hoppes Mfg. Co., Springfield, Ohio
Patterson-Kelley Co., N. Y.
Swartwout Co., Cleveland
Watson & McDaniel Co., Phila.
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Expansion Joints
Carey Co., Philip, Lockland, Cinn.
Griscom-Russell Co., N. Y.
Ross Heater & Mfg. Co., Buffalo
Wheeler Condenser & Engineering Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.

Fans, Exhaust and Ventilator
(See Blowers, Fan)

Feed Water, Make Up Plants
Griscom-Russell Co., N. Y.

Filters, Feed Water
Blackburn-Smith Corp., N. Y.
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.

Filters, Oil
Bowser & Co., S. F., Fort Wayne, Ind.
Burt Mfg. Co., Akron, Ohio
Elliott Co., Jeannette, Pa.
Nugent & Co., Wm. W., Chicago

Filters, Oil System
Bowser & Co., S. F., Fort Wayne, Ind.
Nugent & Co., Wm. W., Chicago

Filters, Oil, Removal
Permutit Co., N. Y.
Reisert Auto Water Purifying Co., N. Y.

Filters, Pressure
Cochrane Corp., Phila.

Filters, Water
Permutit Co., N. Y.
Scaife & Sons Co., Wm. B., Pittsburgh

Firebox Blocks
Harbison-Walker Refractories Co., Pittsburgh
McLeod & Henry Co., Troy, N. Y.

Fittings, Ammonia
Greene, Tweed & Co., N. Y.
Reading Steel Casting Co., Bridgeport
Vogt Machine Co., Henry, Louisville
York Mfg. Co., York, Pa.

Fittings, Steel
Reading Steel Casting Co., Bridgeport

Flanges
Dart Mfg. Co., E. M., Providence
Jefferson Union Co., Lexington, Mass.
Jenkins Bros., N. Y.
Power Piping Co., Pittsburgh
Steere Engineering Co., Detroit
Vogt Machine Co., Henry, Louisville

Floats
Hercules Float Works, Springfield, Mass.
Reliance Gauge Column Co., Cleveland

Flooring, Industrial
Johns-Manville, Inc., N. Y.

Foundations, Machinery
Ballard, Sprague & Co., N. Y.

Fuel Oil Systems
Bethlehem (Pa.) Shipbuilding Corp.
Coen Co., San Francisco
Combustion Eng. Corp., N. Y.
Morse Dry Dock & Repair Co., Brooklyn, N. Y.
National Airoil Burner Co., Phila.
Peabody Engineering Corp., N. Y.

Furnace Construction
Cement Gun Co., Allentown, Pa.
Jointless Fire Brick Co., 1144 Clay St., Chicago

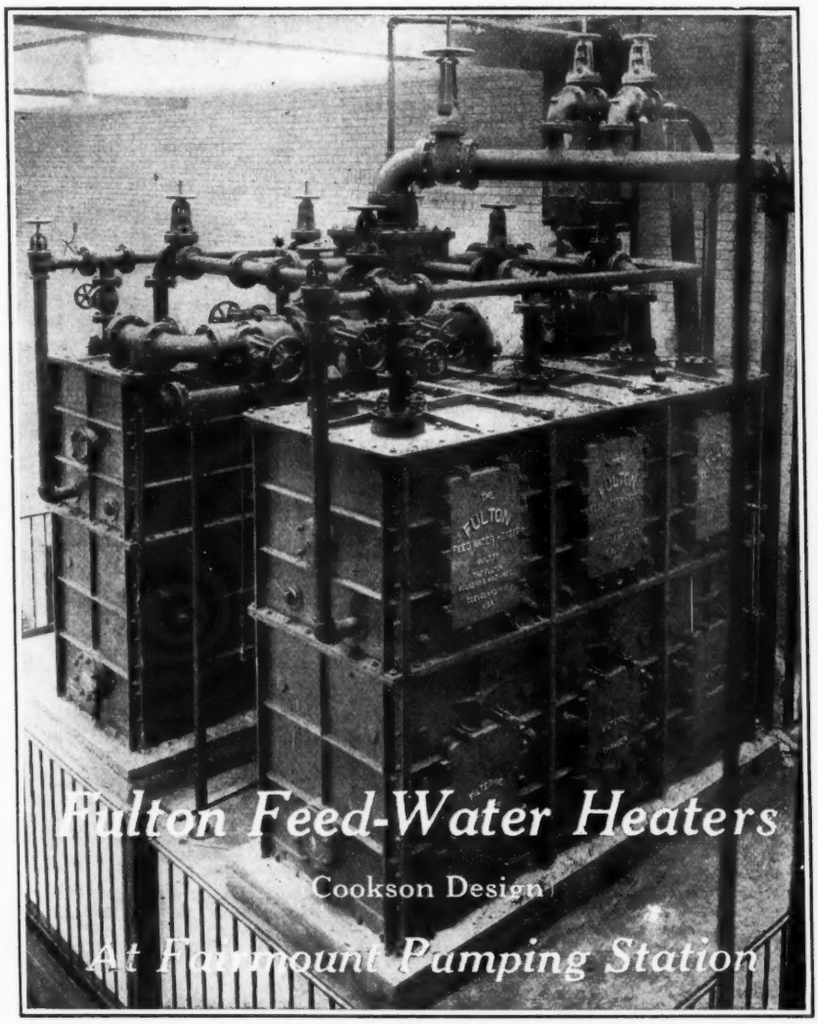
Furnace Arches
Betson Plastic Fire Brick Co., Rome, N. Y.
Bigelow Arch Co., Detroit
Detrick Co., M. H., Chicago
Hofft Co., M. A., Indianapolis
Lavino & Co., E. J., Phila.
Liptak Fire Brick Arch Co., Chicago

Furnace Bottoms, Cast Iron Air Cooled
Allen, Sherman, Hoff Co., Phila.

Furnace Linings
Betson Plastic Fire Brick Co., Rome, N. Y.
Cement Gun Co., Allentown, Pa.
General Refractories Co., Phila.
Harbison-Walker Refractories Co., Pittsburgh
Jointless Fire Brick Co., 1144 Clay St., Chicago

Fairmount Pumping Station *Selects* "Fulton" Feedwater Heaters

The Fairmount Pumping Station is the first station to be built in accordance with Cleveland's fifty million dollar, twenty-year program of water-works construction. It should interest users of feed-water heaters to know that this thoroughly modern plant selected Fulton Feed Water Heaters (Cookson design).



Two independent open-type Fulton Feed Water Heaters connected by a water distributing box, arranged to operate, singly or in parallel.

The returns and make up water are fed into the distributing box and are equally distributed to either or both heaters.

Exhaust steam is supplied from steam driven auxiliaries and low-pressure bleeder turbines at 10 lbs. gage.

All the returns are reheated.

All the steam used in heating is saved, and the boilers are fed with water at or above the boiling point.

The water inlet piping and suction piping are arranged so that either heater may be cut out of service for cleaning or inspection.

Operation is entirely automatic.

Our unit system of construction made it possible to give the required storage capacity in a limited platform space.

These heaters were installed as recommended by our engineering department which is under the personal supervision of Mr. T. J. Cookson. Consult Mr. Cookson about your feed water heater requirements.

The Fulton Foundry & Machine Co.

ENGINEERS · FOUNDERS · MACHINISTS

Cleveland ····· 7311 Morgan Avenue ····· **Ohio**

Feed Water Heaters - Separators - Exhaust Heads

Laclede-Christy, St. Louis
Lavino & Co., E. J., Phila.

Furnaces
Combustion Engineering Corp., N. Y.
Detroit Stoker Co., Detroit
Fuller-Lehigh Co., Fullerton, Pa.
Hofft Co., M. A., Indianapolis
Illinois Stoker Co., Alton, Ill.

Furnaces, Bagasse & Wood Burning
Combustion Engineering Corp., N. Y.
McClave-Brooks Co., Scranton, Pa.

Furnaces, Incinerator
Combustion Engineering Corp., N. Y.
McClave-Brooks Co., Scranton, Pa.

Fuses
General Electric Co., Schenectady

Gage Cocks
(See Cocks, Gage)

Gage Glass Guards & Shields
Huyette Co., Paul B., Phila.
Rogers Co., H. A., N. Y.

Gage Glasses
Chesterton Co., A. W., Boston
Garlock Packing Co., Palmyra, N. Y.
Rogers Co., H. A., N. Y.

Gages, Draft
Bacharach Industrial Instr. Co.
7008 Bennett St., Pittsburgh
Bristol Co., Waterbury, Conn.
Peabody Engineering Corp., N. Y.
Taylor Instrument Companies, Rochester

Gages, Pressure
American Schaeffer & Budenberg Corp., Brooklyn
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Phila.
Taylor Instrument Companies, Rochester

Gages, Recording
American Schaeffer & Budenberg Corp., Brooklyn
Bristol Co., Waterbury, Conn.

Gages, Vacuum
Bacharach Industrial Instr. Co., 2008 Bennett St., Pittsburgh
Bristol Co., Waterbury, Conn.
Greene, Tweed & Co., N. Y.

Gages, Water
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Reliance Gauge Column Co., Cleveland
Williams Gauge Co., Pittsburgh

Gas Exhausters
Buffalo Forge Co., Buffalo, N. Y.
General Electric Co., Schenectady

Gaskets
Advance Packing & Supply Co., Chicago
Garlock Pack. Co., Palmyra, N. Y.
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Smooth-On Mfg. Co., Jersey City, N. J.
United States Rubber Co., N. Y.

Gates, Coal & Ash Bin
Allen, Sherman, Hoff Co., Phila.
Baker, Dunbar Co., Cleveland
Beaumont Co., R. H., Phila.
Brown Hoist. Mach. Co., Cleveland
Conveyors Corp. of America, Chicago
Link-Belt Co., Chicago

Gears
Earle Gear & Machine Co., Phila.
Foote Bros. Gear & Mach. Co., Chicago
Ganschow Co., Wm., 1009 Washington Blvd., Chicago
General Electric Co., Schenectady
Link-Belt Co., Chicago

Gears, Double Helical
De Laval Steam Turbine Co., Trenton, N. J.

Gears, Reduction
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Wellsville, N. Y.
Foote Bros. Gear & Mach. Co., Chicago
Ganschow Co., Wm., 1009 Washington Blvd., Chicago
Moore Steam Turbine Co., Wellsville, N. Y.

Generating Sets
Allis-Chalmers Mfg. Co., Milwaukee
General Electric Co., Schenectady
Ridgway (Pa.) Dynamo & Engine Co.

Generators, Electric
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Ridgway (Pa.) Dynamo & Engine Co.

Governors, Pressure
Northern Equipment Co., Erie, Pa.

Governors, Pump
Atlas Valve Co., Newark, N. J.
Chaplin-Fulton Mfg. Co., Pittsburgh
Davis Regulator Co., G. M., Chicago
Northern Equipment Co., Erie, Pa.
Squires Co., C. E., E. 40th St. and Kelly Ave., Cleveland
Strong, Carlisle & Hammond, Cleveland
Williams Gauge Co., Pittsburgh

Governors, Water-Wheel
Lombard Governor Co., Ashland, Mass.

Graphite
Garlock Pack. Co., Palmyra, N. Y
Greene, Tweed & Co., N. Y.

Grate Bars & Clips
Riley Stoker Corp., Worcester

Grates
Babcock & Wilcox Co., N. Y.
CoKal Stoker Corp., Chicago
Combustion Eng. Corp., N. Y.
Cyclone Grate Bar Co., Buffalo
Delaney & Co., P., Newburgh, N. Y
Flynn & Emrich Co., Baltimore
Kelly Foundry & Mach. Co., Goshen Ind.
McClave-Brooks Co., Scranton, Pa.
Marion Mch., Fdry. & Supply Co. Marion, Ind.
Neemes Foundry, Inc., Troy, N. Y.
Riley Stoker Corp., Worcester
Vogt Mach., Co., H., Louisville, Ky.

Grates, Round
McClave-Brooks Co., Scranton, Pa.

Grease
Keystone Lubricating Co., Phila.
Waverly Oil Works Co., Pittsburgh

Grease Extractors
Blackburn-Smith Corp., N. Y.
Griscom-Russell Co., N. Y.
Elliott Co., Jeannette, Pa.

Grinders, Air and Elec. Portable
Chicago Pneumatic Tool Co., N. Y.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., N. Y.

Heaters, Air
Combustion Engineering Corp., N. Y.
Howden & Co. of America, James, N. Y.
Prat-Daniel Corp., N. Y.

Heaters, Deaerating
Cochrane Corp., Phila.

Heaters, Domestic
Ross Heater & Mfg. Co., Buffalo

Heaters, Feed Water
Bethlehem (Pa.) Shipbuilding Corp.
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Fulton Foundry & Mach Co., Cleveland
Griscom-Russell Co., N. Y.
Hoppes Mfg. Co., Springfield, Ohio
Patterson-Kelley Co., N. Y.
Permutit Co., N. Y.
Swartwout Co., Cleveland
Wheeler Cond. & Eng. Co., Carteret, N. J.

Heaters, Metering
Cochrane Corp., Phila.

Heaters, Oil
Bethlehem (Pa.) Shipbuilding Corp.
Coen Co., San Francisco
Griscom-Russell Co., N. Y.
Power Specialty Co., N. Y.

Heaters, Steam Stack
Cochrane Corp., Phila.

Heaters, Storage
Cochrane Corp., Phil

Heating and Ventilating Systems
Buffalo Forge Co., Buffalo, N. Y
Clarage Fan Co., Kalamazoo, Mich.

Hoists, Air
Chicago Pneumatic Tool Co., N. Y.

Hoists, Electric
Beaumont Co., R. H., Phila.

Hoists, Portable
Sullivan Machinery Co., Chicago

Hoists, Steam
Sullivan Machinery Co., Chicago

Hoppers, Coal and Ash
Allen-Sherman-Hoff Co., Phila.
Baker, Dunbar Co., Cleveland
Beaumont Co., R. H., Phila.
Combustion Engineering Corp., N. Y.
Conveyors Corp. of Amer., Chicago

Hose, Air
Chicago Pneumatic Tool Co., N. Y.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburgh

Hose, Rubber
Quaker City Rubber Co., Wissinoming, Phila.
United States Rubber Co., N. Y.

Hose, Steam
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburgh

Hose, Tube Cleaner
Liberty Mfg. Co., Pittsburgh

Hose, Water
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Ice Machine Repairs
Underwood Corp., H. B., Phila.

Ice and Refrigerating Machinery
(See Refrigerating Machinery)

Indicators, Speed
Biddle, James G., Phila.
Zernickow, O., N. Y.

Indicators, Steam Engine
Bacharach Industrial Instr. Co., 7008 Bennett St., Pittsburgh

Injectors
Jenkins Bros., N. Y.
Penberthy Injector Co., 1236 Holden Ave., Detroit

Insulation
Johns-Manville, Inc., N. Y.

Insulation, Heat
Carey Co., Philip, Lockland, Cinn.
Celite Products Co., Chicago

Lamps, Arc
General Electric Co., Schenectady

Lamps, Incandescent
General Electric Co., Schenectady

Lubricants
Empire Refineries, Inc., Tulsa, Okla.
Keystone Lubricating Co., Phila.
Waverly Oil Works Co., Pittsburgh

Lubricants, Cylinder
Bowser & Co., S. F., Fort Wayne, Ind.
Greene, Tweed & Co., N. Y.
Keystone Lubricating Co., Phila.

Lubricators, Force Feed
Bethlehem (Pa.) Shipbuilding Corp.
Bowser & Co., S. F., Fort Wayne, Ind.
Greene, Tweed & Co., N. Y.
Lunkenheimer Co., Cincinnati
Penberthy Injector Co., 1236 Holden Ave., Detroit
Powell Co., Wm., Cincinnati

Machine Work, Special
Griscom-Russell Co., N. Y.

Metal, Bearing
Magnolia Metal Co., N. Y.

Meters, Air
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., 2222 Diversey Pkway., Chicago

Meters, Boiler
Republic Flow Meters Co., 2222 Diversey Pkway., Chicago

Meters, Electric
General Electric Co., Schenectady

Meters, Feed Water
Cochrane Corp., Phila.
Republic Flow Meters Co., 2222 Diversey Pkway., Chicago
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Flow
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., 2222 Diversey Pkway., Chicago
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Gas
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., 2222 Diversey Pkway., Chicago

Meters, Oil
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., 2222 Diversey Pkway., Chicago

Meters, Steam
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., 2222 Diversey Pkway., Chicago

Meters, V-Notch
Cochrane Corp., Phila.
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Volumetric
Cochrane Corp., Phila.

Meters, Water
Cochrane Corp., Phila.
General Electric Co., Schenectady
Hoppes Mfg. Co., Springfield, Ohio.
Republic Flow Meters Co., 2222 Diversey Pkway., Chicago
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Weighing
Cochrane Corp., Phila.

Motors, Electric
General Electric Co., Schenectady
Ridgway (Pa.) Dyn. & Eng. Co.

Motors, Water
Roto Co., Hartford, Conn.

Oil and Grease Cups
Keystone Lubricating Co., Phila.
Lunkenheimer Co., Cincinnati
Penberthy Injector Co., 1236 Holden Ave., Detroit
Powell Co., Wm., Cincinnati

Oil-Diesel Engine
Empire Refineries, Inc., Tulsa, Ola.

Oil-Fuel
Empire Refineries, Inc., Tulsa, Ola.

Oil, Lubricating
Empire Refineries, Inc., Tulsa, Ola.
Keystone Lubricating Co., Phila.
Waverly Oil Wks. Co., Pittsburgh

Oil Purifiers, Centrifugal
De Laval Steam Turbine Co., Trenton, N. J.

Oil Reclaimers
Bowser & Co., S. F., Fort Wayne, Ind.

Oil Reservoirs
Burt Mfg. Co., Akron, Ohio

Oilers, Telescopic & Centrifugal
Bowser & Co., S. F., Fort Wayne, Ind.
Nugent & Co., Wm. W., Chicago

Oilers, Sight Feed & Multiple
Bowser & Co., S. F., Fort Wayne, Ind.
Lunkenheimer Co., Cincinnati
Nugent & Co., Wm. W., Chicago

Oiling Devices and Systems
Bowser & Co., Fort Wayne, Ind.
Burt Mfg. Co., Akron, Ohio
Elliott Co., Jeannette, Pa.
Nugent & Co., Wm. W., Chicago

Packing, Asbestos
Advance Packing & Supply Co., Chicago
Crandall Packing Co., Palmyra, N. Y.
Garlock Pack. Co., Palmyra, N. Y.
Johns-Manville, Inc., N. Y.

Packing, Centrifugal Pump
Garlock Pack. Co., Palmyra, N. Y.

Packing, Cylinder
Chesterton Co., A. W., Boston

Packing, Flax
Chesterton Co., A. W., Bost

Packing, Flexible Metallic
France Packing Co., Phila.
Garlock Pack. Co., Palmyra, N. Y.

Packing, Hydraulic
Garlock Pack. Co., Palmyra, N. Y.

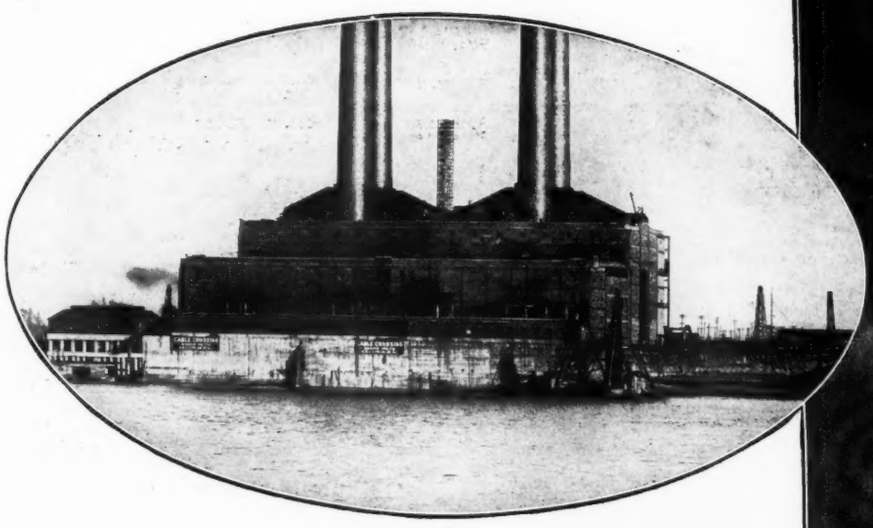
Packing, Metallic
France Packing Co., Phila.
Garlock Pack. Co., Palmyra, N. Y.
Merrill & Co., Wm. B., Boston

Packing, Piston
Chesterton Co., A .W., Boston
Garlock Pack. Co., Palmyra, N. Y.
Johns-Manville, Inc., N. Y.
United States Rubber Co., N. Y.

Packing, Pump Valve
Garlock Pack. Co., Palmyra, N. Y

Packing, Rod
Crandall Packing Co., Palmyra, N. Y.
Garlock Pack. Co., Palmyra, N. Y.
Greene, Tweed & Co., N. Y.
Johns-Manville, Inc., N. Y.
Merrill & Co., Wm. B., Boston
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
United States Rubber Co., N. Y.

Packing Sheet
Advance Packing & Supply Co., Chicago
Crandall Packing Co., Palmyra, N. Y.
Garlock Pack. Co., Palmyra, N. Y.
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Johns-Manville, Inc., N. Y.
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
United States Rubber Co., N. Y.



After 16 months at Cahokia

After sixteen months service on a 750° F. superheat line at Cahokia, a section of Carey Hi-Temp heat insulation was removed for exhibition at the New York Power Show.

The photograph at the right shows this section just before it was taken off the pipe.

Note the tight joints, *showing absolutely no shrinkage.*

The mechanical strength of this insulation after sixteen months exposure to 750° is demonstrated by the shipment of this section from Cahokia to New York intact.

Carey Hi-Temp heat insulation is durable and does not shrink. It has higher efficiency and is also lighter in weight than any other superheat insulation. With all these advantages it is moderate in price. Actual service proves that Carey Hi-Temp has solved the problems of durable, efficient insulation of superheat lines.

Write for further information and samples of Carey Heat Insulations.

The Philip Carey Company

Lockland **Cincinnati, Ohio**

Carey HEAT INSULATIONS

For every need—from residence to super-power-plant

A section of Carey Hi-Temp on a superheat line at Cahokia after 16 months service. Note the tight joints showing absolutely no shrinkage. Photo unretouched.

Packing, Valve Stem
France Packing Co., Phila.
Garlock Pack. Co., Palmyra, N. Y

Paints
Wailes Dove-Hermiston Corp., N. Y.

Pipe
Midwest Piping & Supply Co., St. Louis
National Valve & Mfg. Co., Pittsburgh
Power Piping Co., Pittsburgh
Steere Engineering Co., Detroit

Pipe Bending
Power Piping Co., Pittsburgh

Pipe, Brass & Copper
Scovill Mfg. Co., Waterbury

Pipe Coils
Abendroth & Root Mfg. Co., N. Y.

Pipe Cutters
Greenfield (Mass.) Tap & Die Corp.

Pipe Cutting & Threading Machines
Curtis & Curtis Co., Bridgeport.
Toledo (Ohio) Pipe Threading Mach. Co.

Pipe Fittings
Jefferson Union Co., Lexington, Mass.
Power Piping Co., Pittsburgh
Steere Engineering Co., Detroit

Pipe Joint Paste
Key Boiler Equipment Co., E. St. Louis, Ill.

Pipe Spiral Riveted
Abendroth & Root Mfg. Co., N. Y.

Pipe Threaders
Greenfield (Mass.) Tap & Die Corp.

Pipe, Welded, Seamless
Steere Engineering Co., Detroit

Piping Contractors
Midwest Piping & Supply Co., St Louis
National Valve & Mfg. Co., Pittsburgh
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Power Piping Co., Pittsburgh
Steere Engineering Co., Detroit

Piping Fabricators
Midwest Piping & Supply Co., St. Louis
Steere Engineering Co., Detroit

Piping, High Pressure
Midwest Piping & Supply Co., St. Louis
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Power Piping Co., Pittsburgh
Steere Engineering Co., Detroit

Power Transmission Machinery
Allis-Chalmers Mfg. Co., Milwaukee
Foote Bros. Gear & Mach. Co., Chicago
Link-Belt Co., Chicago
Morse Chain Co., Ithaca, N. Y.

Pre-Heaters, Air
Combustion Engineering Corp., N. Y.
Howden & Co. of America, James, N. Y.
Prat-Daniel Corp., N. Y.

Pulleys
Greene, Tweed & Co., N. Y.
Link-Belt Co., Chicago

Pulleys, Magnetic
Magnetic Mfg. Co., 263 23d Ave., Milwaukee

Pulverized Coal Equipment
Bonnot Co., Canton, Ohio
Combustion Engr. Corp., N. Y.
Erie City Iron Works, Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.

Pulverizers, Coal
Bonnot Co., Canton, Ohio

Pumps, Air
Elliott Co., Jeannette, Pa.
Wheeler Condenser & Eng. Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.

Pumps, Boiler Feed
Allis-Chalmers Mfg. Co., Milwaukee
Bethlehem (Pa.) Shipbuilding Corp.
Coppus Eng. Corp., Worcester
De Laval Steam Turbine, Trenton, N. J.
Earle Gear & Machine Co., Phila.
Lecourtenay Co., Newark, N. J.
Moore Steam Turbine Corp., Wellsville N. Y.
Platt Iron Works, Dayton, Ohio
Vogt Brothers Mfg. Co., Louisville
Warren (Mass.) Steam Pump Co.

Pumps, Centrifugal
Allis-Chalmers Mfg. Co., Milwaukee
Bethlehem (Pa.) Shipbuilding Corp.
Buffalo Forge Co., Buffalo, N. Y.
Coppus Eng. Corp., Worcester
De Laval Steam Turbine Co., Trenton, N. J.
Earle Gear & Machine Co., Phila.
Goulds Mfg. Co., Seneca Falls, N. Y.
Kingsford Fdry. & Mch. Wks., Oswego, N. Y.
Lecourtenay Co., Newark, N. J.
Manistee (Mich.) Iron Wks. Co.
Moore Steam Turbine Corp., Wellsville, N. Y.
Taber Pump Co., Buffalo
Terry Steam Turbine Co., Hartford
Warren (Mass.) Steam Pump Co.

Pumps, Condenser
Elliott Co., Jeannette, Pa.
Wheeler Mfg. Co., C. H., Phila.

Pumps, Deep Well
Westco-Chippewa Pump Co., Davenport, Ia.

Pumps, Force Feed (See Lubricators)

Pumps, Fuel Oil Service
Bethlehem (Pa.) Shipbuilding Corp.
Dean Bros. Co., Indianapolis

Pumps, Mine
Allis-Chalmers Mfg. Co., Milwaukee
Vogt Brothers Mfg. Co., Louisville

Pumps, Oil
Bethlehem (Pa.) Shipbuilding Corp.
Bowser & Co., S. F., Fort Wayne, Ind.
Coen Co., San Francisco
Dean Bros. Co., Indianapolis
Vogt Brothers Mfg. Co., Louisville

Pumps, Power
Buffalo Steam Pump Co., Buffalo
Dean Bros. Co., Indianapolis
Goulds Mfg. Co., Seneca Falls, N. Y.
Platt Iron Wks., Dayton, Ohio
Warren (Mass.) Steam Pump Co.

Pumps, Rotary
Taber Pump Co., Buffalo
Wheeler Mfg. Co., C. H., Phila.

Pumps, Steam
Bethlehem (Pa.) Shipbuilding Corp.
Buffalo Steam Pump Co., Buffalo
Manistee (Mich.) Iron Wks. Co.
Vogt Brothers Mfg. Co., Louisville
Warren (Mass.) Steam Pump Co.
Westco-Chippewa Pump Co., Davenport, Ia.

Pumps, Turbine
Allis-Chalmers Mfg. Co., Milwaukee
Bethlehem (Pa.) Shipbuilding Corp.
Elliott Co., Wellsville, N. Y.
Moore Steam Turbine Corp., Wellsville, N. Y.
Terry Steam Turbine Co., Hartford

Pumps, Vacuum
Elliott Co., Jeannette, Pa.
Sullivan Machinery Co., Chicago
Warren (Mass.) Steam Pump Co.
Wheeler Mfg. Co., C. H., Phila.

Pumps, Water-Works
Allis-Chalmers Mfg. Co., Milwaukee

Purifiers, Feed Water
Cochrane Corp., Phila.
Hoppes Mfg. Co., Springfield, O.
Permutit Co., N. Y.
Yarnall-Waring Co., Mermaid Ave. Phila.

Purifiers, Oil
Bowser & Co., S. F., Fort Wayne, Ind.

Purifiers, Steam
Andrews-Bradshaw Co., 530 Fourth Ave., Pittsburgh
Cochrane Corp., Phila.

Pyrometers
Bacharach Ind. Instr. Co., 7008 Bennett St., Pittsburgh
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Phila.
Leeds & Northrup Co., Phila.
Taylor Instrument Companies, Rochester

Recorders, Draft
Bacharach Ind. Instr. Co., 7008 Bennett St., Pittsburgh

Recorders, Vacuum
Bacharach Ind. Instr. Co., 7008 Bennett St., Pittsburgh

Refrigerating Machinery
Vilter Mfg. Co., Milwaukee
Vogt Mch. Co., Henry, Louisville
York Mfg. Co., York, Pa.

Regulators, Blower
McClave-Brooks Co., Scranton, Pa.

Regulators, Damper, Draft and Fan
Canady Eng. Co., N. Y.
Carrick Engr. Co., Chicago
Hagan Corp, Pittsburgh
Northwestern Mfg. Co., Milwaukee
Smoot Engr. Corp., N. Y.

Regulators, Feed Water
Chaplin Fulton Mfg. Co., Pittsburgh
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Squires Co., C. E., E. 40th & Kelley Sts., Cleveland
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Engineer Co., N. Y.
Mason Regulator Co., Boston, Mass
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Squires Co., C. E., E. 40th & Kelley Ave., Cleveland
Strong, Carlisle & Hammond Co., Cleveland
Taylor Instrument Companies, Rochester
Watson & McDaniel Co., Phila.

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Edward Valve & Mfg. Co., E. Chicago, Ind.
Mason Regulator Co., Boston, Mass.
Northern Equipment Co., 110 W. 11th Sts., Erie, Pa.
Skeen & Co., D. H., Chicago
Squires Co., C. E., E. 40th St. & Kelley Ave., Cleveland
Strong, Carlisle & Hammond Co., Cleveland

Regulators, Stoker
Carrick Engr. Co., Chicago
Northwestern Mfg. Co., Milwaukee

Regulators, Temperature
Atlas Valve Co., Newark, N. J.
Sarco Co., N. Y.
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Reservoirs, Oil
Bowser & Co., Inc., S. F., Fort Wayne, nd.
Coatesville (Pa.) Boiler Wks.

Rheostats
General Electric Co., Schenectady

Roofing & Siding, Asbestos
Johns-Manville, Inc., N. Y.

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Rope Transmission
American Mfg. Co., Brooklyn
American Steel & Wire Co., Chicago
Hunt Co., C. W., W. New Brighton, N. Y.

Rope, Wire
American Mfg. Co., Brooklyn

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Quaker City Rubber Co., Wissinining, Phila.

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Gifford-Wood Co., Hudson, N. Y.
Link-Belt Co., Chicago

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Independent Electric Mchy. Co.
Kehoe, Robt. P.
Nashville Industrial Corp.
O'Brien Mchy. Co.
Phoenix Utility Co.
Power Mchy. Exchange
Randle Mchy. Co.
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Gifford-Wood Co., Hudson, N. Y.
Strong, Carlisle & Hammond Co., Cleveland

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Griscom-Russell Co., N. Y.
Strong, Carlisle & Hammond Co., Cleveland
Swartwout Co., Cleveland
Wright-Austin Co., 321 W. Woodbridge St., Detroit

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Cochrane Corp., Phila.

Separators, Steam
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Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Fulton Fdry. & Mach. Co., Cleveland
Griscom-Russell Co., N. Y.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Patterson-Kelley Co., N. Y.
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Wiederholdt Constr. Co., St. Louis

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Ballard, Sprague & Co., N. Y.
Custodis Chimney Constr. Co., Alphons, New York

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Erie City Iron Wks., Erie, Pa.
Union Iron Works, Erie, Pa.

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American Engr. Co., Phila.
Combustion Engineering Corp., N. Y
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Riley Stoker Corp., Worcester
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Combustion Eng. Corp., N. Y.
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Stops, Engine
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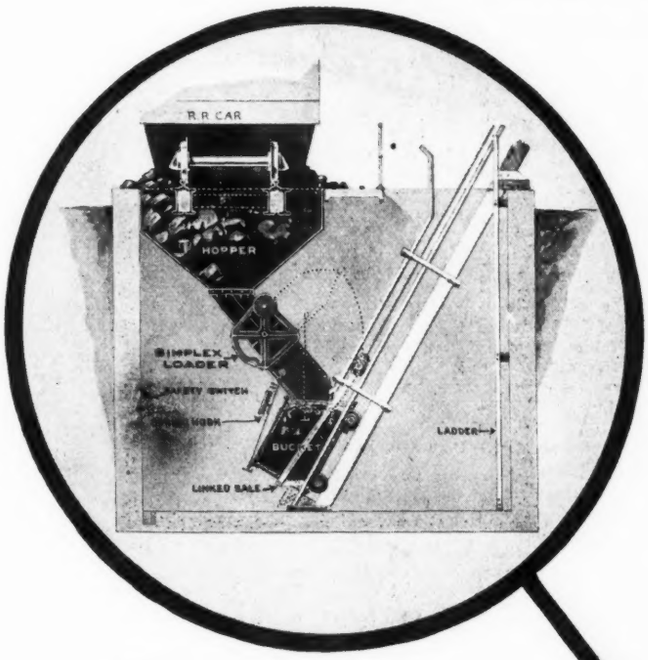
BEAUMONT SKIP HOISTS
for Coal or Ashes



Beaumont Simplex Loader
(Patented)

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HERE is the Simplex Loader which is indispensable for successful skip hoist operation. Opened and closed only by contact with the skip bucket, its self-damming character assures the skip hoist of working at its maximum capacity, as the skip bucket cannot be under-loaded nor can it be flooded. This device is one of the outstanding developments of the Beaumont Skip Hoist, reflecting the years of thought and care necessary to develop so highly a successful fuel handling medium.

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General Electric Co., Schenectady

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Ganschow Co., Wm., Chicago

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(See Power Transmission Machinery)

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Sarco Co., N. Y.
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Tubes, Boiler, Lap Welded
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Moore Steam Turbine Corp., Wellsville, N. Y.
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Nason Mfg. Co., N. Y.

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Elliott Co., Jeannette, Pa.
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